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During June 1987, researchers from the Naval Ocean Research and Development Activity (NORDA) participated in a cruise in the Norwegian Sea aboard the WFS *Planet*. They collected high-precision conductivity-temperature-depth (CTD) measurements at fifty-one (51) stations using a Neil Brown Mark IIIB CTD with an attached in situ fluorometer. The CTD stations were situated along one transect between the Shetland and Faeroe Islands and along three other transects which crossed frontal boundaries in the Norwegian Sea proper. Many of the stations were coincident with orbits of the Navy's GEOSAT satellite. From these data, the dynamic height at each station will be calculated in order to correlate and verify GEOSAT altimetric measurements with oceanographic data long the altimeter ground tracks.

This report describes the preliminary results produced by NORDA from the WFT *Planet* cruise, NORDMEER 87. The purpose of the cruise is described and a detailed listing of station locations and data collected are provided. All procedures used for instrument calibration, data collection, verification, and processing are given. Vertical profiles of potential temperature, salinity (PSS78), sigma theta and relative chlorophyll fluorescence are presented for each station. A plot of potential temperature versus salinity for each station is also given. Contour plots of temperature and salinity for the four transects are used to describe the different water masses in the region.

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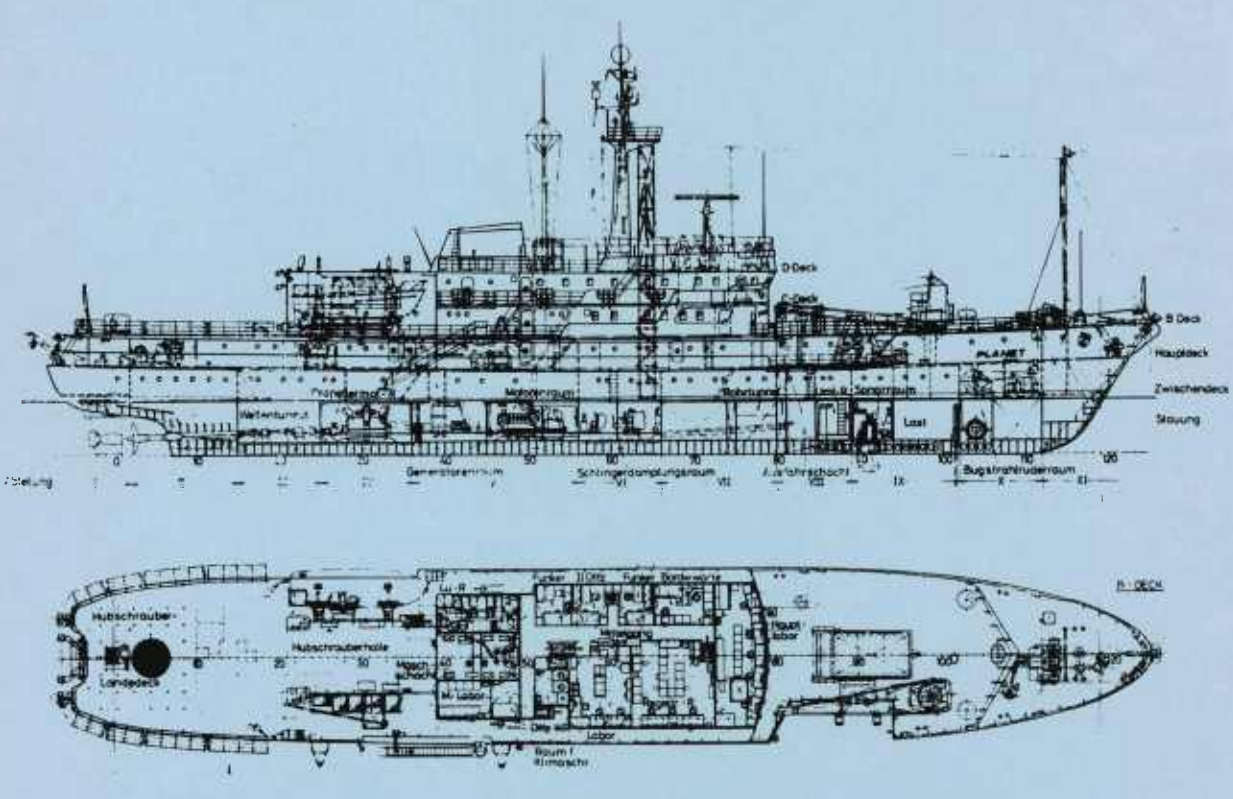
# CTD Measurement from the Norwegian Sea during NORDMEER 87 June 1987, WFS *Planet*

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August 1987

## ABSTRACT

During June 1987, researchers from the Naval Ocean Research and Development Activity (NORDA) participated in a cruise in the Norwegian Sea aboard the WFS PLANET. They collected high precision conductivity-temperature-depth (CTD) measurements at fifty-one (51) stations using a Neil Brown Mark IIIB CTD with an attached in situ fluorometer. The CTD stations were situated along one transect between the Shetland and Faeroe Islands and along three other transects which crossed frontal boundaries in the Norwegian Sea proper. Many of the stations were coincident with orbits of the Navy's GEOSAT satellite. From these data, the dynamic height at each station will be calculated in order to correlate and verify GEOSAT altimetric measurements with oceanographic data along the altimeter ground tracks.

This report describes the preliminary results produced by NORDA from the WFS PLANET cruise, NORDMEER 87. The purpose of the cruise is described and a detailed listing of station locations and data collected are provided. All procedures used for instrument calibration, data collection, verification and processing are given. Vertical profiles of potential temperature, salinity (PSS78), sigma theta and relative chlorophyll fluorescence are presented for each station. A plot of potential temperature versus salinity for each station is also given. Contour plots of temperature and salinity for the four transects are used to describe the different water masses in the region.

## ACKNOWLEDGMENTS

The authors wish to thank the Captain and crew of the WFS PLANET for their cooperation in making NORDMEER 87 a successful field experiment. We also thank Herr Jurgen Sellschopp, Chief Scientist during NORDMEER 87, for inviting us to participate in this exercise and to all the scientists aboard PLANET who helped us overcome the language barrier. Special thanks are due to Mr. Arnie Schuetz of NRL who assisted in the CTD launchings, regardless of the weather, to Kim David Saunders who provided the CTD plotting programs and to Ms. Laura Wise who typed the manuscript. An additional thanks is given to Neptune, god of the sea, who was forgiving in his treatment of us as we crossed the Arctic Circle. This work was funded by the Office of Naval Research, Program Elements 61153N and 63207N, through the NORDA Defense Research Sciences Program.

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# CTD MEASUREMENTS FROM THE NORWEGIAN SEA DURING NORDMEER 87, JUNE 1987, WFS PLANET

## INTRODUCTION

The Naval Ocean Research and Development Activity (NORDA) is a participant in the U.S. Navy Space Oceanography Program whose overall objective is to use satellite derived data (thermal infrared, radar altimeter, etc.) in interpretation of ocean dynamics and thermodynamics. One goal of this program is to learn how to effectively use satellite sea surface measurements to improve our knowledge of air-sea interaction processes and to input these results into numerical models. In situ ocean measurements coincident with satellite data are a required component of the Space Oceanography Program, as such measurements are important in validation of remotely sensed satellite data.

To accomplish its mission, the Space Oceanography Program arranged NORDA participation in a cruise to the Norwegian Sea during June 1987. The purpose of this field experiment was two-fold: The primary purpose of the experiment was to collect high precision conductivity-temperature-depth (CTD) measurements along transects which cross frontal boundaries. The station locations were coincident with orbits of the Navy's GEOSAT satellite. The CTD data from each station will be used to calculate the dynamic height at each station in order to correlate and verify GEOSAT altimetric measurements with oceanographic data along the altimeter ground tracks. In a secondary effort, the CTD was also fitted with an in situ fluorometer which allows the measurement of chlorophyll fluorescence in the ocean. These data will be used by NORDA's Biological and Chemical Oceanography Branch to estimate variability in phytoplankton biomass across the oceanic frontal boundaries that were encountered during the cruise.

### Cruise Description

This field exercise was conducted aboard the Wehrforschungsschiff (WFS) PLANET, an 80 meter research vessel (see cover drawing) operated by the Forschungsanstalt der Bundeswher fur Wasserschall- und Geophysik (FWG) out of Kiel, Federal Republic of Germany (FRG). Herr Jurgen Sellschopp of FWG was Chief Scientist during the cruise, which was designated NORDMEER 87. The PLANET departed from Kiel, FRG on 01 June 1987 and returned to Kiel, FRG on 19 June 1987. An intermediate port call was made in Trondheim, Norway from 1000 hrs 08 June 1987 to 1000 hrs 09 June 1987. Between 01 and 19 June 1987, 51 CTD stations were successfully completed in the Norwegian Sea by NORDA personnel. One additional STD (salinity-temperature-depth) station was collected by FWG personnel using the Plessey STD aboard the PLANET.

In addition to the CTD and STD stations occupied during the cruise, FWG scientist towed a thermistor chain with 60 thermistors to a depth of 180 m and a Schleppfisch (Batfish) was towed in an oscillating mode to a depth of 100 m. The Schleppfisch made continuous measurements of temperature, salinity, depth and sound velocity. A second Schleppfisch was towed by personnel from the Marineamt Laboratory in Wilhelmshaven, FRG. Requests for information on these data should be addressed to the Chief Scientist at FWG, Klausdorfer Weg 2-24, 2300 Kiel 14, FRG (tel. 49-431-7204-123). During the cruise, personnel from the U.S. Naval Research Laboratory (NRL) continuously

operated an RD Instruments acoustic doppler current profiler (ADCP) to obtain real-time measurements of currents down to a depth of several hundred meters. They also operated a Trimble global positioning system (GPS) navigation unit, which has an internal LORAN-C receiver, to provide continuous, precise position during the cruise. Those concerned about these data should contact Dr. Clifford Trump, NRL, Code 5140, Washington, D.C. 20375 USA (tel. 202-767-2528). This report will concern itself only with the CTD data collected by NORDA during the cruise. Cruise participants, their affiliation and dates that they were aboard WFS PLANET are given in Table 1.

After departing Kiel, FRG at 1300 hrs on 01 June 1987, WFS PLANET proceeded through the North-East Canal (NORD-OSTSEE-KANAL) which connects the Baltic Sea to the North Sea. PLANET then proceeded through the North Sea toward the Shetland Islands. The first CTD station was occupied at 60°14.3N, 002°25.8W in the vicinity of the Shetland Islands on 03 June 1987. A transect of nine (9) CTD stations was occupied between the Shetland and Faeroe Islands and is designated the Shetland-Faeroe Transect. The location of all CTD stations taken during the cruise is shown in Figure 1. Stations were occupied in sequential order. After this CTD transect, a second CTD transect was made beginning at 65°48.6N, 001°30.6W (Station 10) on 06 June 1987 and continued southeast toward the Norwegian coast. The stations along this transect were taken at crossover points of the GEOSAT satellite track and are designated GEOSAT Transect 1. After Station 18 was completed, PLANET transited to Trondheim, Norway to disembark several scientists and to embark one (see Table 1). Upon leaving Trondheim, a third CTD transect (Stations 19-34, GEOSAT Transect 2) was conducted and completed on 11 June 1987. After this transect, the FWG thermistor chain and the Batfish were towed for several days along the solid lines shown in Figure 1 (points D-L).

After this period, CTD stations were resumed on 15 June 1987 with Station 35 at 65°56.5N, 005°17.8W and sampling was continued until Station 51 was completed on 17 June 1987. Stations 39-51 were again coincident with GEOSAT tracks at crossover points and this transect was designated GEOSAT Transect 3. At approximately the same location as Station 51, Station 52 was occupied using the FWG Plessey STD for comparison. At the completion of Station 52, WFS PLANET proceeded south along the coast of Norway, through the Baltic Sea and arrived Kiel, FRG at 2000 hrs 19 June 1987.

## METHODS

### Field Data Collection

Vertical temperature and conductivity measurements were made using a Neil Brown Instruments Systems, Inc. MARK IIIB CTD System (Serial No. 2301-01). This CTD system has been modified by the addition of an extra data channel that digitizes a 0-5 Volt DC analog signal from an external sensor and transmits it as part of the normal CTD data cycle. During NORDMEER 87, a SeaMarTech, Inc. Model 6000 in situ fluorometer was interfaced to the CTD via this extra channel. Prior to the cruise, the CTD system was calibrated and operationally checked by the Sensor Calibration Laboratory of the U.S. Naval Oceanographic Office (NAVOCEANO). A post-cruise check of the instrument was also conducted by NAVOCEANO to insure that the unit had remained in calibration during the cruise. Thus, at the beginning and end of the cruise the CTD was certified to be operating within the manufacturers specified accuracies. In the pre-cruise check the CTD had a temperature

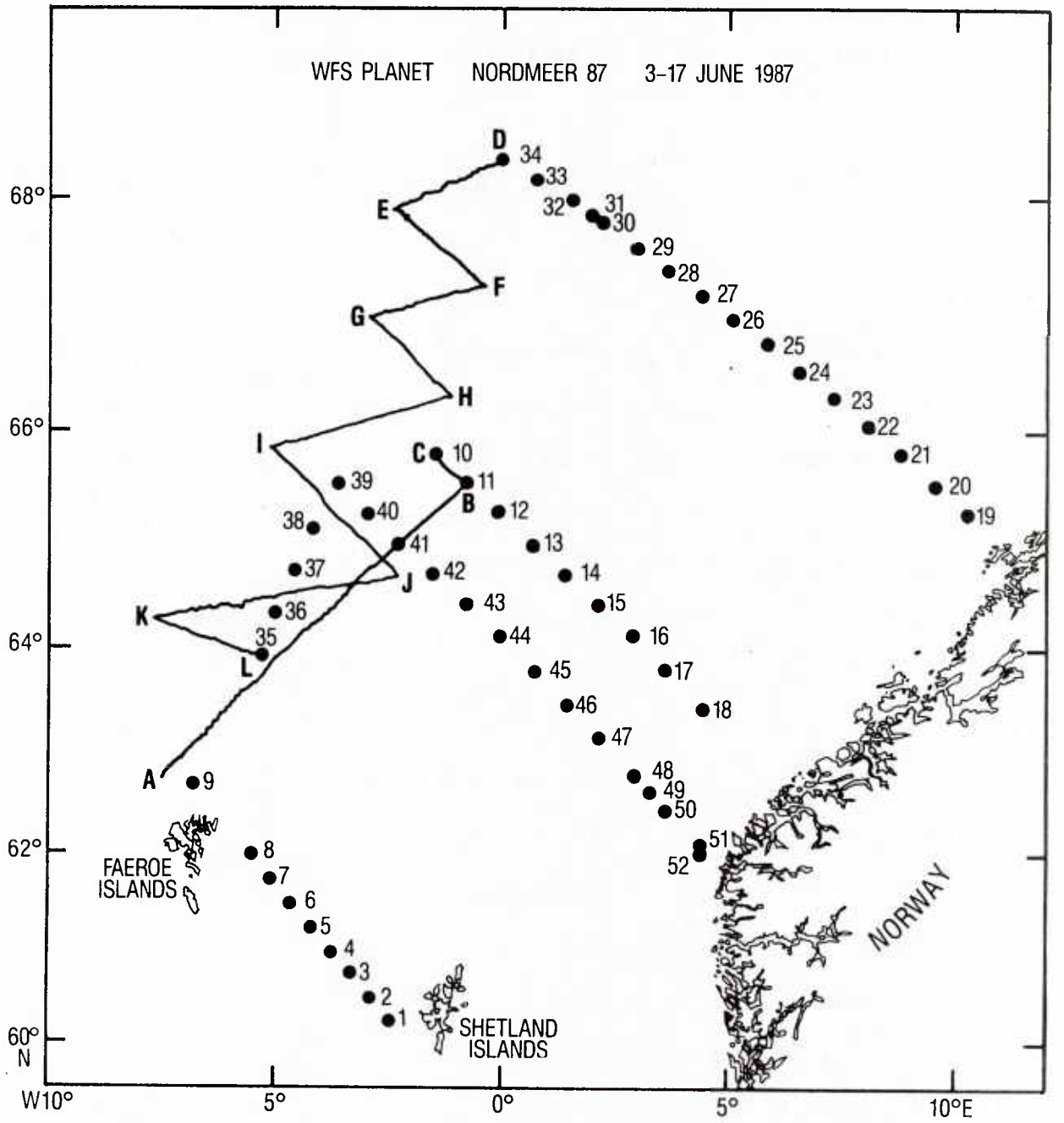


Figure 1. Station location map WFS PLANET cruise NORDMEER 87. Solid lines indicate track over which the thermistor chain and batfish were towed.

Table 1. Scientific Party, WFS PLANET, NORDMEER 87 Cruise, 01-19 June 1987.

| Name | Affiliation | Dates Aboard |
|---|---|---|
| Dieter Beling | FWG[1] | 1-19 June 87 |
| Jorg Beyer | Fachhocschule Kiel | 1-8 June 87 |
| Claus Bode | FWG | 1-19 June 87 |
| Hans Ebel | FWG | 1-8 June 87 |
| Jurgen Heidotting | MarA/Geophys[2] | 1-19 June 87 |
| George F. Krebs | Sverdrup Technology, Inc. | 1-19 June 87 |
| Dr. B. Edward McDonald | NORDA[3] | 1-8 June 87 |
| Niecke | Fachhochschule Kiel | 1-8 June 87 |
| Dr. Steve A. Piacsek | SACLANTCENTRE[4] | 1-8 June 87 |
| Dr. Pavel Pistek | NORDA | 8-19 June 87 |
| Rabe | FWG | 1-19 June 87 |
| Arnim F. Schuetz | NRL[5] | 1-19 June 87 |
| Jurgen Sellschopp | FWG (Chief Scientist) | 1-19 June 87 |
| Dr. Klaus-Jochen Stepputat | FWG | 1-19 June 87 |
| Jorg Theis | MarA/Geophys | 1-19 June 87 |
| Jan Tiefensee | FWG | 1-19 June 87 |
| Dr. Clifford Trump | NRL | 1-8 June 87 |
| Dr. Denis A. Wiesenburg | NORDA | 1-19 June 87 |
| Dr. Karl O. Westphal | FWG | 1-19 June 87 |

[1]Forschungsanstalt der Bundeswehr fur Wasserschall- und Geophysik, Kiel, FRG

[2]Marineamt, Stabsabteilung Geophysik, Wilhelmshaven, FRG

[3]Naval Ocean Research and Development Activity, NSTL, Mississippi, USA

[4]SACLANT ASW Research Centre, La Spezia, Italy

[5]Naval Research Laboratory, Washington D.C., USA

error of -0.002°C at 7.78°C and an error of -0.003°C at 0.749°C. The conductivity error (at salinity = 34.736) at 7.79°C was -0.003 and was -0.005 at 0.75° C. These conductivity errors were used to correct the CTD data collected to allow salinity (Practical Salinity Scale - 1978, PSS78) to be calculated with a precision of better than 0.001. The conductivity offsets were linear ($r^2$ = 0.9750) with temperature, thus a correction equation was derived for conductivity using the calibrations at 0.7468° C, 7.7888° C and 15.3089° C. The conductivity was corrected before salinity was calculated. A sample of the pre-cruise calibration data for the CTD used during NORDMEER 87 is presented in Table 2. No temperature correction was made since the temperature offset of the CTD was less than 0.01° C.

At each CTD station, the CTD-fluorometer package was deployed from the starboard hydrographic winch aboard PLANET on an electromechanical cable electronically interfaced to the CTD readout/data logging system. On deck readings of temperature and pressure were recorded and the CTD was placed just below the surface so surface measurements of pressure, temperature, conductivity and fluorescence could be recorded. The CTD was then lowered at a rate of 25 meters per minute for the first 100 m and then at a rate of 50 meters per minute to the maximum depth obtained. As the CTD package was lowered through the water column, the serial data transmissions from the CTD were recorded on analog tape and also digitized in 0.5 - 1.0 decibar (dbar) averages and the averages are stored on a cassette tape. This averaging is accomplished using a Hewlett-Packard 9825B Calculator System which receives data from the Neil Brown Mark IIIB deck unit through an IEEE-488-1978 interface (HBIB). At a lowering speed of 50 m per minute, the 0.5 dbar increments usually represent the average of about three data cycles. These pressure, conductivity, temperature and fluorescence averages were used to produce the preliminary data plots presented in this report.

As the averaging technique described above is not sufficient to produce the quality of CTD data required for dynamic height calculations, a second method of data storage was utilized to provide a high quality digital data set from each CTD station. The serial data sent to the ship from the CTD probe were recorded on analog tape during the cast and the full data stream was simultaneously sent to a Neil Brown Instruments, Inc. Model 1150 Data Terminal. The full data stream was digitized and displayed by this unit and transmitted to a Digi-Data, Inc. 9-track tape recorder for simultaneous digital data recording. These 9-track tapes will be processed to provide high quality temperature and salinity profiles and these data will be used to calculate dynamic height.

The averaged data collected on the ship are of equal quality to the 9-track digital data, only the number of points averaged are fewer. These averaged data were used to produce a matrix of data including pressure, temperature, conductivity and relative fluorescence. The data were collected in 0.5 dbar averages to a depth of 500 dbars and then in 1.0 dbar averages to the maximum cast depth, usually 900 dbars.

Parameter Calculations

From the pressure, temperature and conductivity averages, depth, salinity, potential temperature, and potential density were calculated based on the algorithms given in UNESCO Report 44 (UNESCO 1983). This report provides FORTRAN functions and subroutines which can be used to calculate

Table 2. Neil Brown CTD Calibration Data, S/N: 2301-01, Pre-Cruise 14 April 1987.

| SAMPLE NO. | NO. DATA POINTS | PAVG (DECIBARS) | PDEV | TAVG (DEGREES C) | TDEV | CAVG (MMHOS/CM) | CDEV | ATB TEMP |
|---|---|---|---|---|---|---|---|---|
| 1 | 32 | .5 | .071 | 7.7888 | .00025 | 35.7680 | .00002 | 7.7910 |
| 2 | 32 | .5 | .061 | 7.7889 | .00020 | 35.7680 | .00002 | 7.7909 |
| 3 | 32 | .5 | .071 | 7.7889 | .00017 | 35.7680 | .00002 | 7.7909 |
| 4 | 32 | .5 | .078 | 7.7890 | .00012 | 35.7680 | .00002 | 7.7909 |
| 5 | 32 | .5 | .075 | 7.7891 | .00022 | 35.7680 | .00002 | 7.7909 |
| 6 | 32 | .5 | .055 | 7.7890 | .00009 | 35.7680 | .00002 | 7.7908 |
| 7 | 32 | .5 | .063 | 7.7889 | .00043 | 35.7680 | .00002 | 7.7908 |
| 8 | 32 | .5 | .066 | 7.7886 | .00021 | 35.7680 | .00002 | 7.7907 |
| 9 | 32 | .5 | .061 | 7.7886 | .00022 | 35.7680 | .00002 | 7.7907 |
| 10 | 32 | .5 | .071 | 7.7886 | .00026 | 35.7680 | .00002 | 7.7906 |
| 11 | 32 | .5 | .078 | 7.7888 | .00025 | 35.7680 | .00002 | 7.7905 |
| 12 | 32 | .5 | .071 | 7.7889 | .00029 | 35.7680 | .00002 | 7.7905 |
| 13 | 32 | .5 | .055 | 7.7889 | .00022 | 35.7680 | .00002 | 7.7906 |
| 14 | 32 | .5 | .068 | 7.7886 | .00022 | 35.7680 | .00002 | 7.7907 |
| 15 | 32 | .5 | .084 | 7.7886 | .00021 | 35.7679 | .00025 | 7.7907 |

TOTAL VALUES FOR 15 SECONDS OF DATA:

TOTAL NO. OF SYNC WORDS FOUND = 480
TOTAL NO. OF DATA POINTS = 480
SAMPLES LOST = 0

P AVG = .5 T AVG = 7.7888 C AVG = 35.7680 ATB AVE= 7.7907

**********USING PSS78**********

TEMPERATURES (°C): (T1) STANDARD T = 7.7907 (T2) CTD AVE T = 7.7888

STANDARD CONDUCTIVITY RATIO = .99335

CONDUCTIVITIES (MMHO/CM): (C1) STANDARD ABS C = 35.7728 (C2) STANDARD BIASED C = 35.7711
(C3) CTD AVE COND = 35.7680 (C4) STD TEMP CORR C = 35.7697

SALINITIES (PPT): (S1) STANDARD S = 34.7380 (S2) STD TEMP CORR CTD S = 34.7346 (S3) CTD S = 34.7365

ERRORS: TEMP ERROR (T2-T1) = -.0019
ABS C ERROR (C4-C1) = -.0032
BIASED ERROR (C3-C2) = -.0032
STD SALINITY ERROR (S2-S1) = -.0034 CTD SALINITY ERROR (S3-S1) = -.0015
**NOTE**: THE DECK UNIT DISPLAYED CONDUCTIVITY MUST BE ADJUSTED USING THE BIASED C ERROR!!!!!!

**********

NOTES: NBIS CELL CORRECTIONS USING T1
C2 CALCULATED FROM C1 BIASED USING NBIS CELL CORRECTION
C4 CALCULATED FROM C3 UISING NBIS CELL CORRECTION
S2 CALCULATED USING C4 AND T1
AUTOSAL ASSUMED TO BE OPERATING AT 27°C

these parameters accurately. Appendix A gives the FORTRAN routines used in these calculations. Depth is calculated from pressure based on the algorithm of Saunders and Fofonoff (1976) with the formula refitted for the 1980 Equation of State. This algorithm (Appendix A) requires measurements of only pressure and latitude. Before calculating salinity, the conductivity data from the CTD was corrected based on the pre-cruise calibration data. Temperature differences for the CTD were less than 0.01°C and thus no temperature correction was required. The CTD conductivity offset at 15.3°C (-0.0018 mmhos), 7.8°C (-0.0032) and 0.7°C (-0.0055) was fitted to a linear (r = 0.9875) equation of the form.

$$\text{delta C} = 0.00025332 * t(°C) - 0.00551340. \qquad (1)$$

The CTD temperature (t) values were then used to calculate a CTD conductivity correction (delta C) and this correction was made to conductivity before salinity was calculated. Salinity is calculated from conductivity, temperature and pressure and is reported on the practical salinity scale 1978 (PSS-78). References for the method are found in UNESCO Report No. 37 (1981). Potential temperature (theta) is calculated using Bryden's (1973) polynomial for adiabatic lapse rate and Runge-Kutta 4th order integration algorithm (Bryden 1973; Fofonoff 1977). Density (or potential density; sigma theta) was calculated as a function of practical salinity (S), and potential temperature (t, °C) to yield density in kilograms per cubic meter. The international high pressure equation of state (Millero et. al. 1980, Millero and Poisson 1981) is used along with the density of pure water at atmospheric pressure (Bigg 1967) in the calculation. The algorithms are given in Appendix A and the rational for the method is described in UNESCO Report No. 38 (1981). Sigma theta = (potential density -1) x 1000.

### Navigation Positions

Position locations were determined using either the Decca positioning system aboard WFS PLANET or the NRL GPS-LORAN system which was installed aboard PLANET for this cruise. If enough GPS satellites were in position to allow an accurate navigation fix to be calculated, the GPS fix was accepted for the CTD stations and recorded for the cast. GPS fixes have a nominal accuracy of +/- 10 meters and GPS was the method of choice for determining position. If GPS was not available, then either LORAN-C or Decca was used to obtain the correct position. The Decca system gave very precise positions near the coast. Further from the coast, however, the quality of the Decca positions deteriorated and LORAN-C was used to fix positions far from the coast, when GPS was not available. All positions reported are believed to be accurate to +/- 0.5 kilometer.

## RESULTS

### Station Locations

Table 3 provides complete summary data on each CTD station and cast. Date, time, location, fluorometer scale and number of water samples taken (ST) are provided for each cast. Both date and time are given in Greenwich Mean Time (GMT). Local time was +2 hours relative to GMT. Also listed on the table is the bottom depth (MAX) measured acoustically at each station and the maximum depth (DEPTH) of the CTD cast. The bottom depth is in meters and

Table 3. Station and location description WFS PLANET NORDMEER 87

| STATION | CAST | MAX DEPTH | | ST | DATE | TIME | LATITUDE | LONGITUDE | SENSOR |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 98 | 104 | 0 | 03 June 87 | 1942 | 60 14.26N | 002 25.83W | Fluor5 |
| 2 | 1 | 153 | 166 | 0 | 03 June 87 | 2144 | 60 29.01N | 002 51.50W | Fluor5 |
| 3 | 1 | 500 | 553 | 0 | 03 June 87 | 2351 | 60 44.64N | 003 18.67W | Fluor4 |
| 4 | 1 | 916 | 1124 | 0 | 04 June 87 | 0159 | 60 59.53N | 003 45.10W | Fluor3 |
| 5 | 1 | 609 | 1100 | 0 | 04 June 87 | 0426 | 61 14.54N | 004 11.49W | Fluor3 |
| 6 | 1 | 540 | 612 | 0 | 04 June 87 | 0658 | 61 29.44N | 004 37.71W | Fluor3 |
| 7 | 1 | 203 | 230 | 0 | 04 June 87 | 0908 | 61 44.13N | 005 04.05W | Fluor3 |
| 8 | 1 | 200 | 220 | 0 | 04 June 87 | 1113 | 61 59.04N | 005 30.15W | Fluor3 |
| 9 | 1 | 166 | 180 | 0 | 04 June 87 | 1612 | 62 39.47N | 006 50.05W | Fluor3 |
| 10 | 1 | 924 | 3350 | 0 | 06 June 87 | 1443 | 65 48.61N | 001 30.59W | Fluor3 |
| 11 | 1 | 929 | 3100 | 0 | 06 June 87 | 1733 | 65 33.19N | 000 49.10W | Fluor3 |
| 12 | 1 | 926 | 3010 | 0 | 06 June 87 | 2130 | 65 15.35N | 000 05.04W | Fluor3 |
| 13 | 1 | 914 | 2770 | 0 | 07 June 87 | 0035 | 64 58.88N | 000 39.87E | Fluor3 |
| 14 | 1 | 915 | 3000 | 0 | 07 June 87 | 0336 | 64 41.69N | 001 23.28E | Fluor3 |
| 15 | 1 | 912 | 2500 | 0 | 07 June 87 | 0638 | 64 24.92N | 002 07.35E | Fluor3 |
| 16 | 1 | 910 | 1760 | 0 | 07 June 87 | 0949 | 64 07.32N | 002 52.03E | Fluor3 |
| 16 | 2 | 100 | 1760 | 0 | 07 June 87 | 1044 | 64 07.23N | 002 51.57E | Fluor3 |
| 17 | 1 | 910 | 1510 | 0 | 07 June 87 | 1327 | 63 47.73N | 003 36.16E | Fluor3 |
| 18 | 1 | 909 | 1280 | 0 | 07 June 87 | 1647 | 63 25.73N | 004 25.45E | Fluor3 |
| 19 | 1 | 137 | 150 | 0 | 09 June 87 | 2153 | 65 15.79N | 010 14.82E | Fluor3 |
| 20 | 1 | 356 | 390 | 0 | 10 June 87 | 0037 | 65 31.95N | 009 31.29E | Fluor3 |
| 21 | 1 | 377 | 415 | 0 | 10 June 87 | 0335 | 65 48.20N | 008 46.04E | Fluor3 |
| 22 | 1 | 358 | 380 | 0 | 10 June 87 | 0707 | 66 03.13N | 008 03.29E | Fluor3 |
| 23 | 1 | 336 | 365 | 0 | 10 June 87 | 0959 | 66 17.71N | 007 18.60E | Fluor3 |
| 24 | 1 | 635 | 678 | 0 | 10 June 87 | 1241 | 66 31.34N | 006 31.31E | Fluor3 |

Table 3(Cont.) Station and location description WFS PLANET NORDMEER 87

| STATION | CAST | MAX DEPTH | | ST | DATE | TIME | LATITUDE | LONGITUDE | SENSOR |
|---|---|---|---|---|---|---|---|---|---|
| 25 | 1 | 902 | 1150 | 0 | 10 June 87 | 1524 | 66 44.96N | 005 50.32E | Fluor3 |
| 26 | 1 | 909 | 1325 | 0 | 10 June 87 | 1821 | 66 58.08N | 005 04.36E | Fluor3 |
| 27 | 1 | 906 | 1600 | 0 | 10 June 87 | 2106 | 67 10.68N | 004 23.95E | Fluor3 |
| 28 | 1 | 909 | 1350 | 0 | 10 June 87 | 2351 | 67 23.50N | 003 36.88E | Fluor3 |
| 29 | 1 | 882 | 1410 | 0 | 11 June 87 | 0237 | 67 35.04N | 002 57.28E | Fluor3 |
| 30 | 1 | 921 | 1830 | 0 | 11 June 87 | 0526 | 67 47.44N | 002 13.42E | Fluor3 |
| 31 | 1 | 910 | 2100 | 0 | 11 June 87 | 0638 | 67 51.12N | 001 58.11E | Fluor3 |
| 32 | 1 | 912 | 2650 | 0 | 11 June 87 | 0835 | 67 58.01N | 001 22.65E | Fluor3 |
| 33 | 1 | 916 | 2920 | 0 | 11 June 87 | 1116 | 68 10.56N | 000 50.02E | Fluor3 |
| 34 | 1 | 910 | 2680 | 0 | 11 June 87 | 1344 | 68 20.03N | 000 04.55W | Fluor3 |
| 34 | 2 | 110 | 2680 | 0 | 11 June 87 | 1420 | 68 19.96N | 000 04.54W | Fluor3 |
| 35 | 1 | 900 | 3340 | 0 | 15 June 87 | 1746 | 63 56.50N | 005 17.77W | Fluor3 |
| 36 | 1 | 920 | 3475 | 0 | 15 June 87 | 2106 | 64 20.30N | 004 59.44W | Fluor3 |
| 36 | 2 | 100 | 3475 | 0 | 15 June 87 | 2141 | 64 20.34N | 004 59.24W | Fluor2 |
| 37 | 1 | 913 | 3450 | 0 | 16 June 87 | 0014 | 64 43.65N | 004 34.00W | Fluor2 |
| 38 | 1 | 908 | 3460 | 0 | 16 June 87 | 0313 | 65 07.28N | 004 08.25W | Fluor3 |
| 39 | 1 | 910 | 3350 | 0 | 16 June 87 | 0612 | 65 31.30N | 003 36.81W | Fluor3 |
| 39 | 2 | 100 | 3350 | 0 | 16 June 87 | 0645 | 65 31.09N | 003 36.99W | Fluor2 |
| 40 | 1 | 913 | 3300 | 0 | 16 June 87 | 0856 | 65 14.90N | 002 56.71W | Fluor2 |
| 41 | 1 | 911 | 3140 | 0 | 16 June 87 | 1151 | 64 59.18N | 002 17.13W | Fluor2 |
| 42 | 1 | 912 | 2950 | 0 | 16 June 87 | 1438 | 64 42.80N | 001 32.23W | Fluor2 |
| 43 | 1 | 913 | 2700 | 0 | 16 June 87 | 1730 | 64 24.77N | 000 48.80W | Fluor2 |
| 44 | 1 | 904 | 2500 | 0 | 16 June 87 | 2030 | 64 06.80N | 000 04.07W | Fluor2 |
| 45 | 1 | 913 | 2250 | 0 | 16 June 87 | 2337 | 63 47.11N | 000 40.87E | Fluor2 |
| 46 | 1 | 903 | 1650 | 0 | 17 June 87 | 0239 | 63 27.67N | 001 24.59E | Fluor2 |
| 47 | 1 | 881 | 1125 | 0 | 17 June 87 | 0550 | 63 07.65N | 002 08.18E | Fluor2 |

Table 3(Cont.) Station and location description WFS PLANET NORDMEER 87

| STATION | CAST | MAX DEPTH | | ST | DATE | TIME | LATITUDE | LONGITUDE | SENSOR |
|---|---|---|---|---|---|---|---|---|---|
| 48 | 1 | 592 | 620 | 0 | 17 June 87 | 0917 | 62 46.55N | 002 54.92E | Fluor3 |
| 48 | 2 | 100 | 625 | 0 | 17 June 87 | 0952 | 62 46.68N | 002 51.88E | Fluor3 |
| 49 | 1 | 328 | 360 | 0 | 17 June 87 | 1136 | 62 35.89N | 003 14.85E | Fluor3 |
| 50 | 1 | 170 | 200 | 0 | 17 June 87 | 1334 | 62 25.37N | 003 36.75E | Fluor3 |
| 51 | 1 | 177 | 210 | 0 | 17 June 87 | 1650 | 62 04.21N | 004 21.32E | Fluor3 |

the CTD depths is given in decibars. Due to cable and time limitations, the maximum sampling depth was limited to about 920 dbars or to within 50 meters of the bottom on shallower stations.

CTD Data Plots

A plot of potential temperature, salinity (PSS78), sigma theta, and relative fluorescence for each station is given in Appendix B. A plot of potential temperature versus salinity is also provided for each station. All plots are not all on the same scale as there were large variations in surface salinity between stations. Near the coast, salinities of less than 33 were recorded, with 35 at depth at the same station. In other stations, salinity variations of less than 0.1 were recorded. To plot all stations on the same salinity scale (32-36) would reduce one's ability to examine any small-scale features on many of the stations. Likewise, all stations were not plotted on the same depth scale. Two scales were used. Stations shallower than 400 m were plotted o a 0-400 m depth scale. All other stations were plotted on a 0-900 m depth scale.

Fluorescence Profiles

The fluorescence data on these plots is presented on a relative scale. The CTD fluorescence output recorded by the CTD varies from 0 to 4096 data bits. The data were divided by 100 and plotted on a 0-45 relative scale in all plots. Without actual extracted chlorophyll determinations collected simultaneously, it is difficult to determine chlorophyll biomass from in situ chlorophyll fluorescence measurements. The fluorescence profiles presented here should thus be used only to examine relative changes between stations, and as a method of determining how the phytoplankton have distributed themselves in the water column in accordance with the temperature or salinity profiles and changes in mixed layer depth.

Temperature and Salinity Transects

To examine the transect data in a more meaningful way, contour maps of temperature and salinity with depth have been produced for the Shetland Faeroe Transect (Figures 2 and 3) which encompasses Stations 1 to 8, and GEOSAT Transect 1 (Station 10-18, Figures 4 and 5), GEOSAT Transect 2 (Stations 19-34, Figures 6 and 7) and GEOSAT Transect 3 (Stations 39-51, Figures 8 and 9). The contour plots are located after the REFERENCES section (p. 14-21). These contour plots were produced aboard the PLANET from the same averaged data used to produce the plots in Appendix B. Total distance was determined along a given CTD transect and stations were locatedaccordingly on the plots. The station locations are given along the bottom of each plot and the transect distance is given in kilometers on the upper scale. The average data was plotted at 10 decibar intervals and contoured by hand to produce the temperature and salinity contour plots. We feel that the fully processed CTD contour plots will have no noticeable difference from those presented here.

## DISCUSSION

The CTD stations and part of thermistor chain and batfish data taken from WFS PLANET were positioned along nadir tracks of GEOSAT altimeter. Except for the Shetland-Faeroe transect, all stations were taken below a

GEOSAT satellite pass, +/- 1 day. The Shetland-Faeroe Transect was taken 9 days after the satellite pass. The main purpose of these measurements was to correlate satellite data (IR and altimeter) with in situ oceanographic measurements in the mesoscale range.

CTD transects were made while crossing the major current inflow into the Norwegian Sea, the Norwegian Atlantic Current. This current is the continuation of the North Atlantic Current. It passes through the Faeroe-Shetland channel and transports into the Norwegian basin relatively warm (about 9°C) and saline (>35) Atlantic Water (AW). It is present in all transects with salinity greater than 35.00 and variable temperature. The strongest flux is near the Norwegian slope with maximum salinity of 35.3 near the Shetland Island and diminishing to 35.15 in GEOSAT Transect 2. Underlying the Atlantic water mass are two stratified layers. The upper layer is primarily Arctic Intermediate water (AIW), defined in accordance with Stefansson (1962) as a water mass with a temperature between 0° and 2°C and salinity between 34.80 and 35.00. Below the AIW is the Norwegian Sea Deep Water (NSDW) with salinity about 34.92 and temperature below 0°C. While AW flows northward, AIW and NSDW flow southward through Faeroe-Shetland channel and are the source for the North Eastern Atlantic Bottom Water. Clearly noticeable is also Norwegian Coastal Water (NCW) carried by the Norwegian Coastal Current. This water has a salinity of less than 35.00 and in summer less than 32.00. It originates in Baltic Sea with contributions from fjords. The NCW is described as a wedge of coastal water extending out from the shore and onto the Atlantic water of the Norwegian Atlantic Current (Johannessen 1986) and is seen in GEOSAT Transects 1, 2, and 3. It is interesting to notice that in GEOSAT Transect 3 this water extends as a 30 m slab about 200 km offshore.

The different systems of warm and cold currents in Nordic Seas causes the formation of ocean fronts. The frontal boundaries are convergence zones of cold, less saline water with warm saline water such that the strong changes in the temperature and salinity compensate each other with regard to density, thereby reducing the density gradients. A very strong front is visible in transects where Norwegian Atlantic and Norwegian Coastal Currents meet. They create the Norwegian Coastal front with large, seasonal salinity gradients. A much weaker front was observed on the west side of Norwegian Atlantic current where Atlantic water encounters the East Icelandic Current, approximately between the Faeroe and Jan Mayen Islands.

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Unesco 1981. Background papers and supporting data on the practical salinity scale, 1978. Unesco Tech. Pap. in Mar. Sci., No. 37, 144 pp.

Unesco 1981. Background papers supporting data on the International Equation of State of Sea Water, 1980. Unesco Tech. Pap. in Mar. Sci., No. 38, 192 pp.

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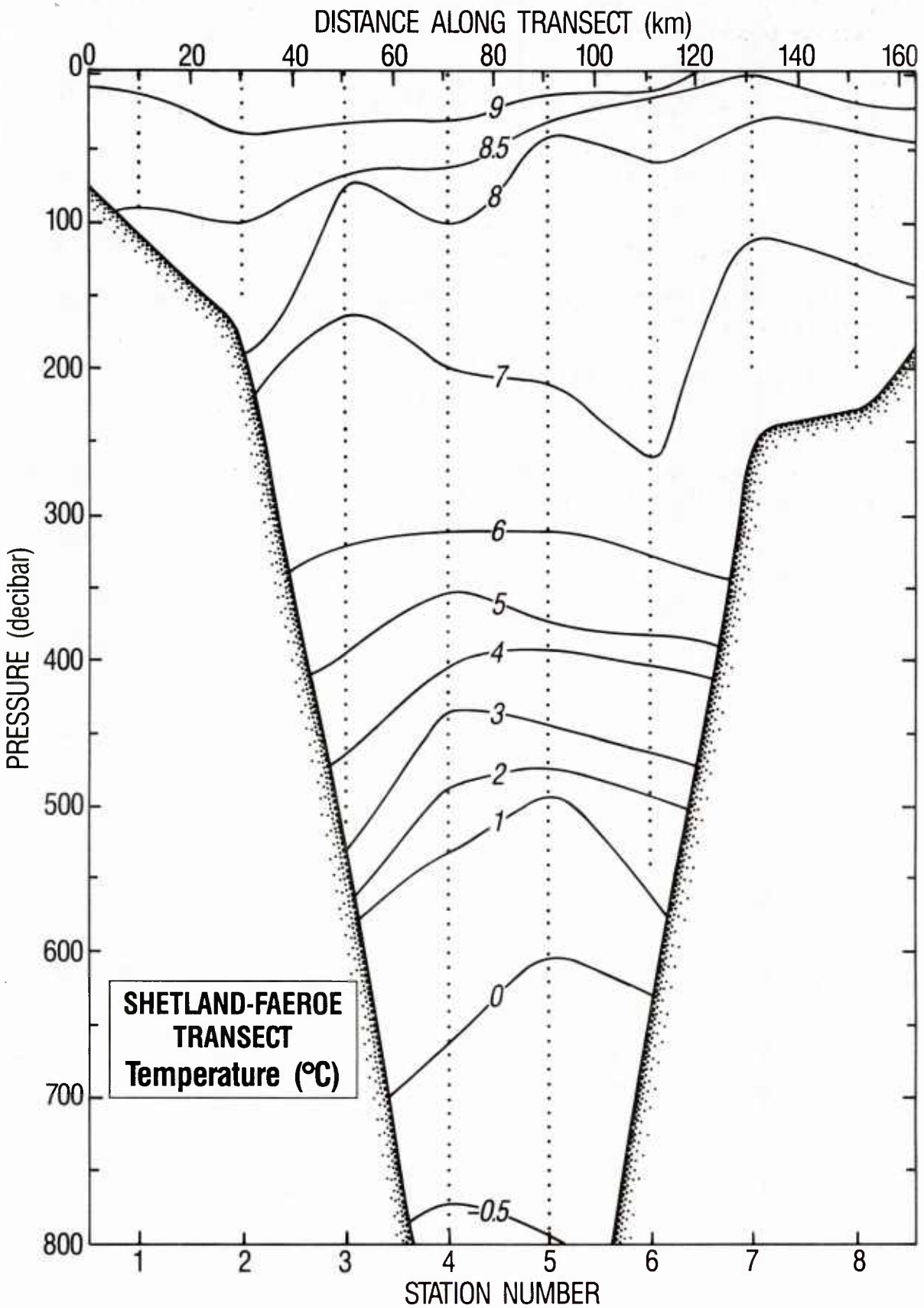



Figure 2. Temperature contours along the Shetland-Faeroe Transect, Stations 1-8.

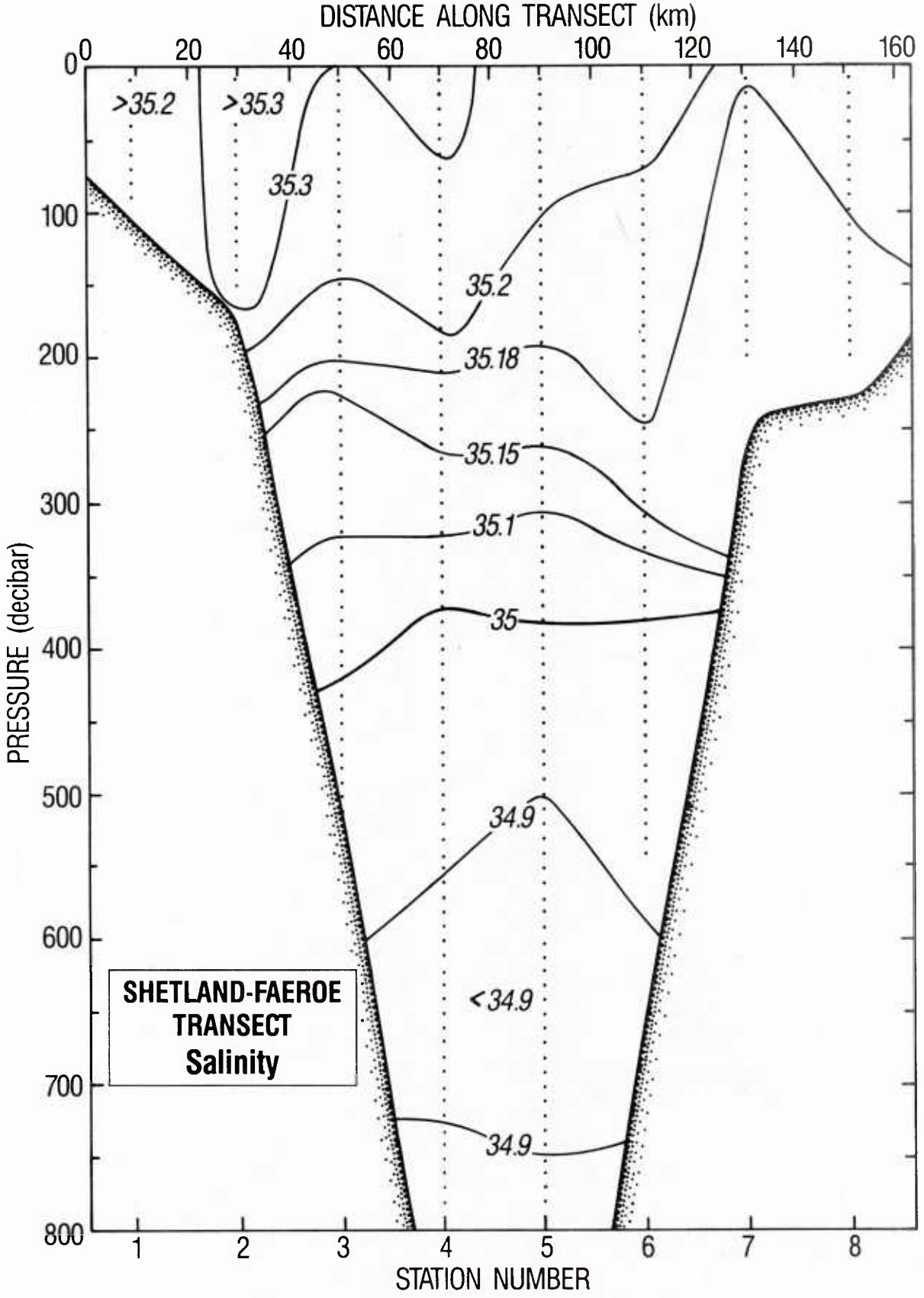



Figure 3. Salinity contours along the Shetland-Faeroe Transect, Stations 1-8.

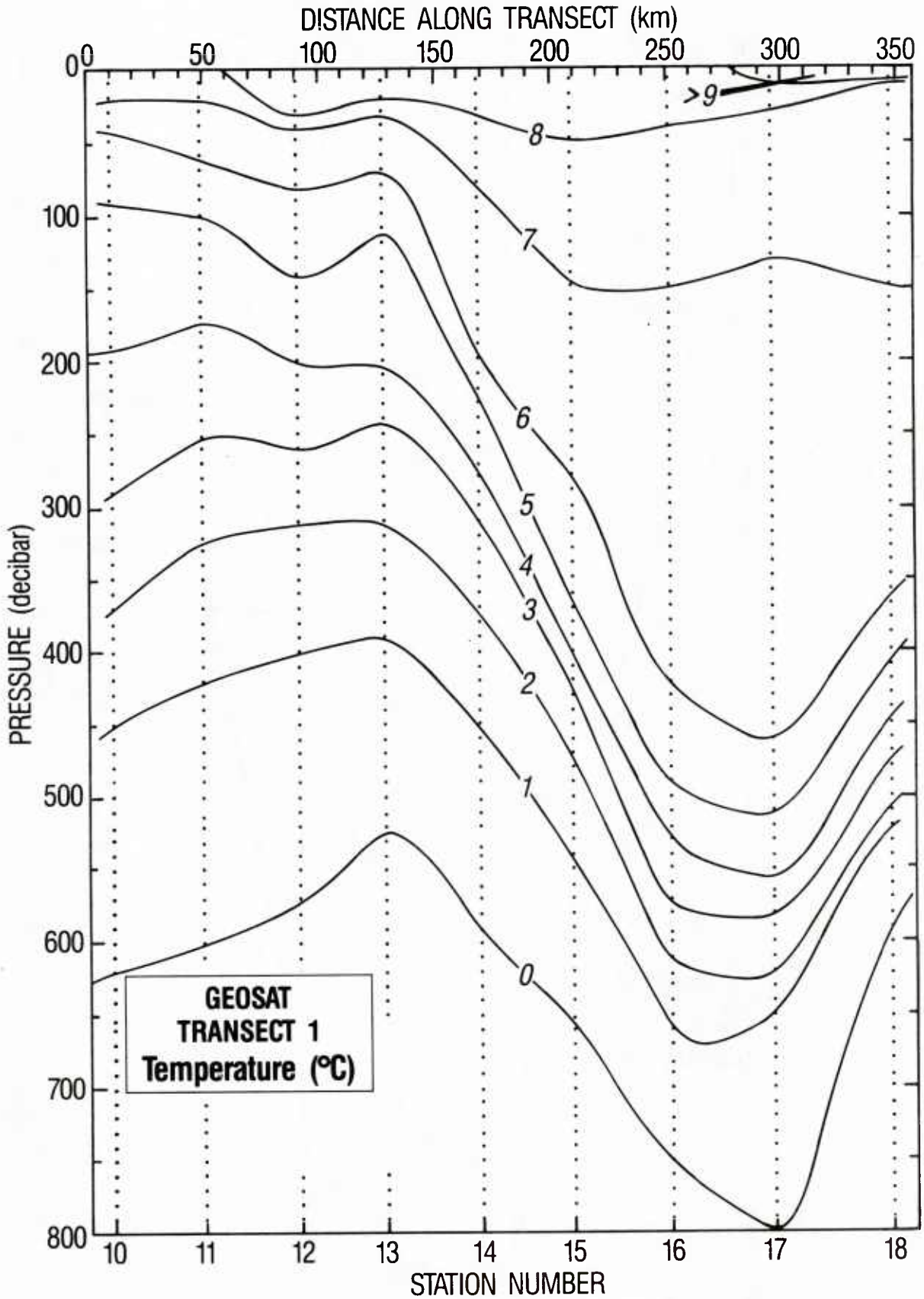



Figure 4. Temperature contours along GEOSAT Transect 1, Stations 10-18.

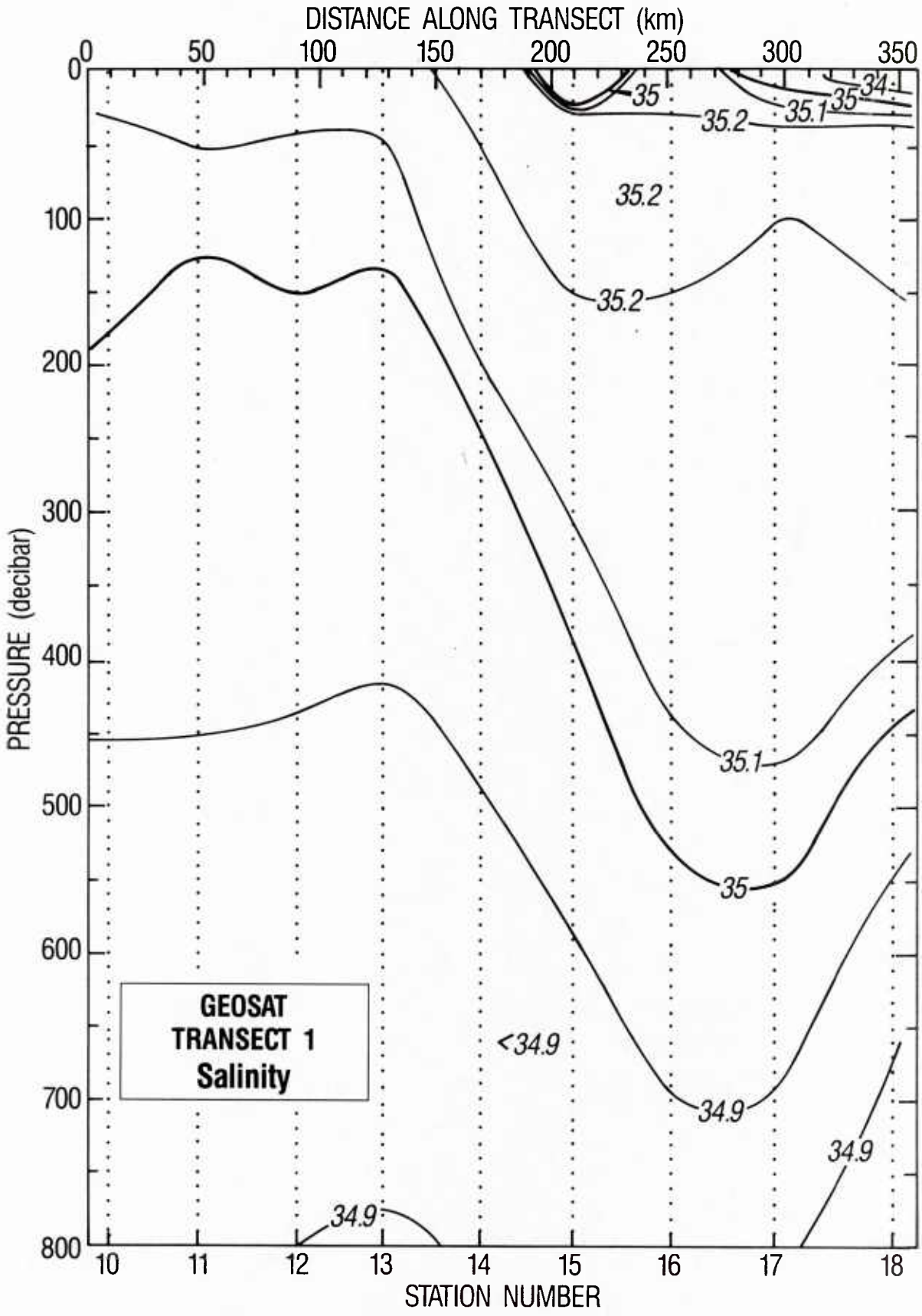



Figure 5. Salinity contours along GEOSAT Transect 1, Stations 10-18.

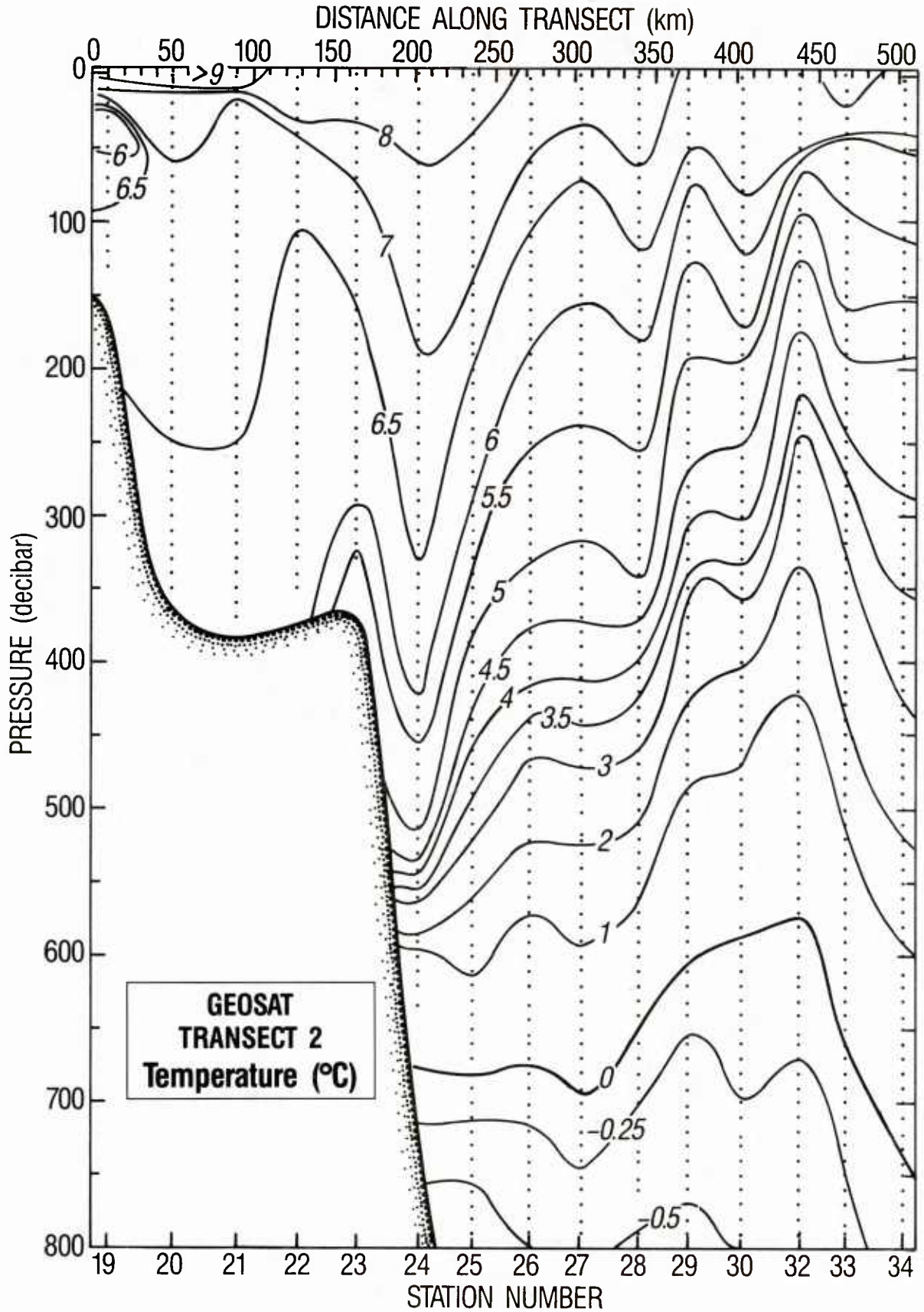



Figure 6. Temperature contours along GEOSAT Transect 2, Stations 19-34.

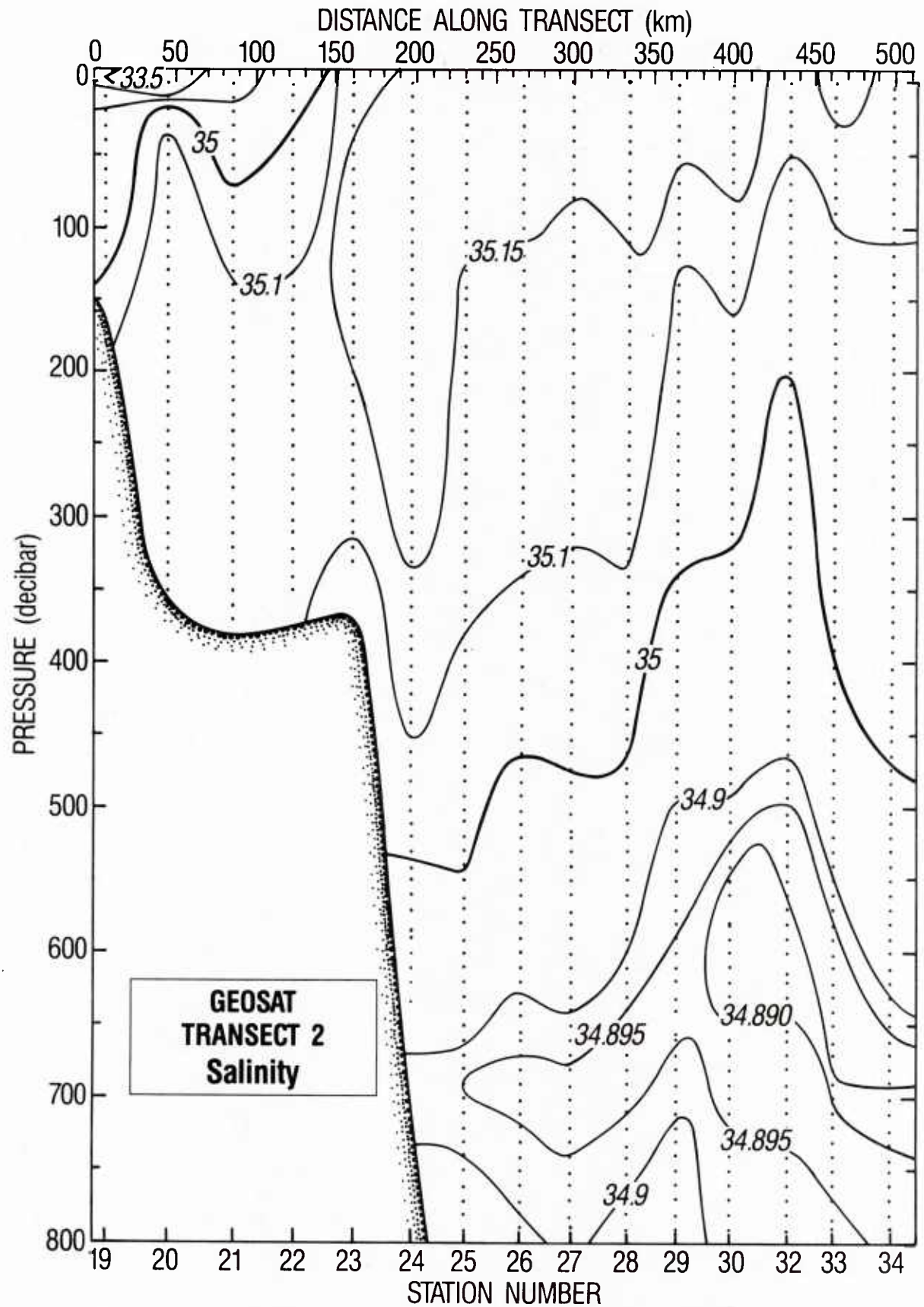



Figure 7. Salinity contours along GEOSAT Transect 2, Stations 19-34.

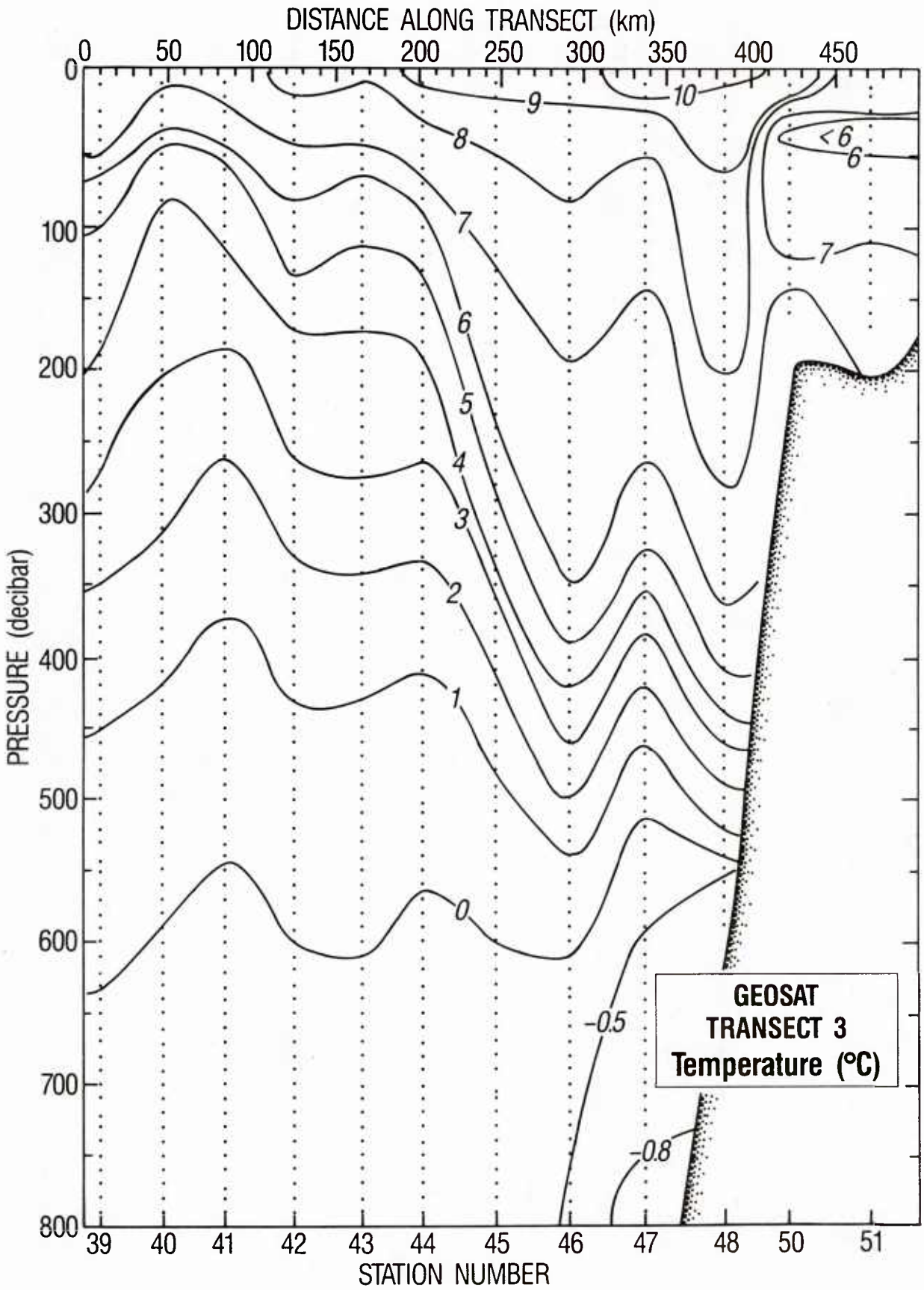



Figure 8. Temperature contours along GEOSAT Transect 3, Stations 39-51.

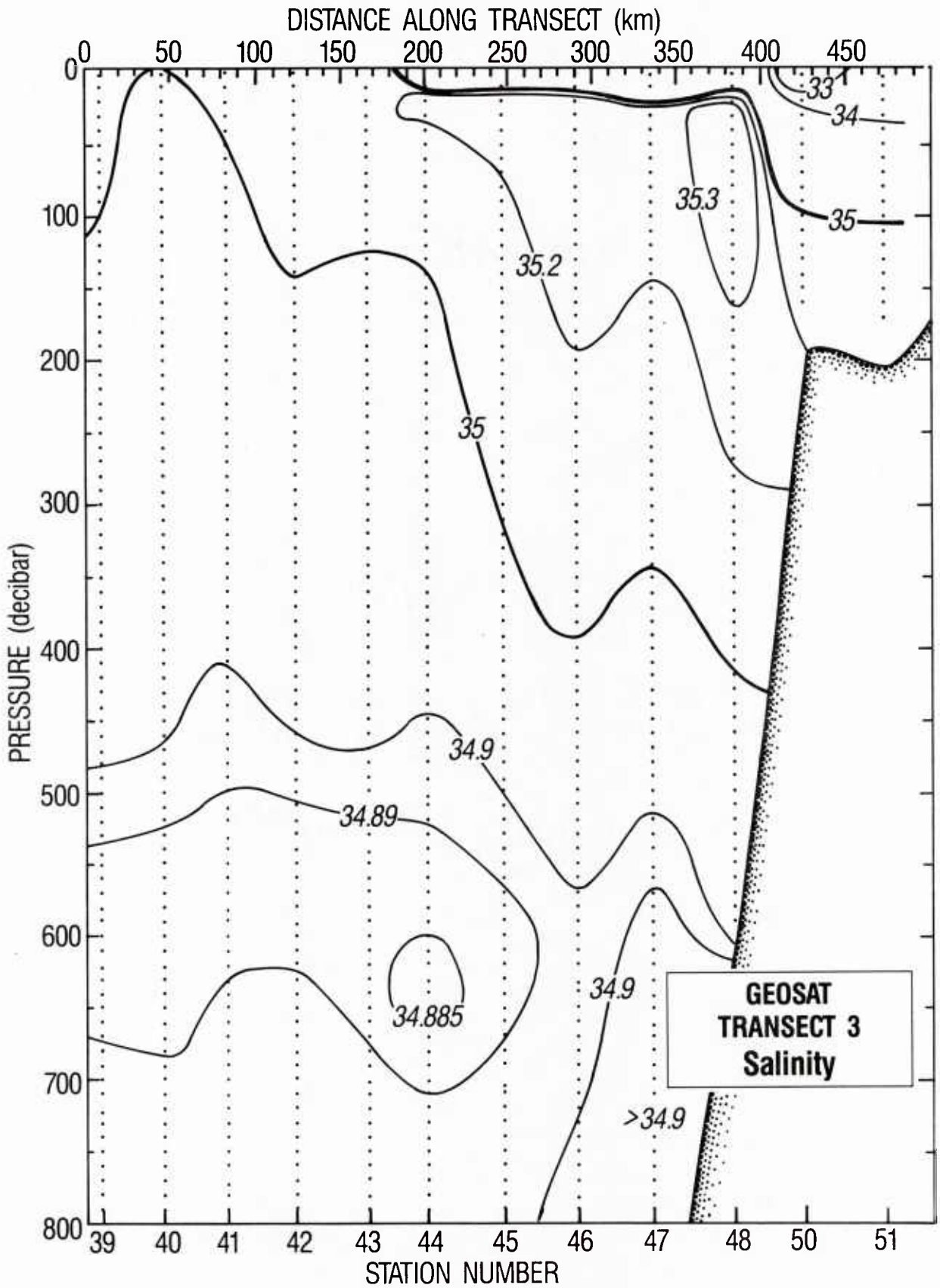



Figure 9. Salinity contours along GEOSAT Transect 3, Stations 39-51.

# APPENDIX A

# CTD DATA CALCULATION PROGRAMS

```
C SAL78 FCN ********** MAR 28 1983 *******
      REAL FUNCTION SAL78(CND,T,P,M)
C ***************************************************************
C     THE CONDUCTIVITY RATIO (CND) = 1.0000000 FOR SALINITY = 35 PSS-78
C     TEMPERATURE = 15.0 DEG. CELSIUS , AND ATMOSPHERIC PRESSURE.
C***************************************************************
C
C FUNCTION TO CONVERT CONDUCTIVITY RATIO TO SALINITY (M = 0)
C SALINITY TO CONDUCTIVITY RATIO (M = 1,CND BECOMES INPUT SALINITY)
C***************************************************************
C   REFERENCES:   ALSO LOCATED IN UNESCO REPORT # 37 1981
C  PRACTICAL SALINITY SCALE 1978: E.L. LEWIS IEEE OCEAN ENG. JAN. 1980
C ***************************************************************
C UNITS:
C       PRESSURE         P        DECIBARS
C       TEMPERATURE      T        DEG CELSIUS (IPTS-68)
C       CONDUCTIVITY     CND      RATIO      (M=0)
C       SALINITY         SAL78    (PSS-78)   (M=0)
C  CHECKVALUES:
C      SAL78=1.888091 :CND= 40.0000,T=40 DEG C,P= 10000 DECIBARS:    M= 1
C      SAL78=40.00000 :CND=1.888091,T=40 DEG C,P=10000 DECIBARS:     M=0
C***************************************************************
C SAL78 RATIO: RETURNS ZERO FOR CONDUCTIVITY RATIO:  < 0.0005
C SAL78: RETURNS ZERO FOR SALINITY:  < 0.02
C ***************************************************************
C INTERNAL FUNCTIONS
C ***************************************************************
C  PRACTICAL SALINITY SCALE 1978 DEFINITION WITH TEMPERATURE CORRECTION
C  XT=T-15.0 : XR=SQRT(RT)
      SAL(XR,XT) =((((2.7081*XR-7.0261)*XR+14.0941)*XR+25.3851)*XR
     X-0.1692)*  XR+0.0080
     X  +(XT/(1.0+0.0162*XT))*(((((-0.0144*XR+
     X   0.0636)*XR-0.0375)*XR-0.0066)*XR-0.0056)*XR+0.0005)
C  DSAL(XR,XT)  FUNCTION FOR DERIVATIVE OF SAL(XR,XT) WITH XR.
      DSAL(XR,XT) =((((13.5405*XR-28.1044)*XR+42.2823)*XR+50.7702)*XR
     X   -0.1692)+(XT/(1.0+0.0162*XT))*((((-0.0720*XR+0.2544)*XR
     X   -0.1125)*XR-0.0132)*XR-0.0056)
C  FUNCTION RT35 :  C(35,T,0)/C(35,15,0) VARIATION WITH TEMPERATURE
C  WITH TEMPERATURE.
      RT35(XT) = (((1.0031E-9*XT-6.9698E-7)*XT+1.104259E-4)*XT
     X   + 2.00564E-2)*XT + 0.6766097
C POLYNOMIALS OF RP: C(S,T,P)/C(S,T,0) VARIATION WITH PRESSURE
C  C(XP) POLYNOMIAL CORRESPONDS TO A1-A3 CONSTANTS: LEWIS 1980
      C(XP) = ((3.989E-15*XP-6.370E-10)*XP+2.070E-5)*XP
      B(XT) = (4.464E-4*XT+3.426E-2)*XT + 1.0
C  A(XT) POLYNOMIAL CORRESPONDS TO B3 AND B4 CONSTANTS: LEWIS 1980
      A(XT) = -3.107E-3*XT + 0.4215
C***************************************************************
C ZERO SALINITY/CONDUCTIVITY TRAP
      SAL78=0.0
      IF((M.EQ.0).AND.(CND.LE.5E-4)) RETURN
      IF((M.EQ.1).AND.(CND.LE.0.02)) RETURN
C ***********************************************
      DT = T - 15.0
```

```
C SELECT BRANCH FOR SALINITY (M=0) OR CONDUCTIVITY (M=1)
      IF(M.EQ.1)  GO TO 10
C ***********************************************
C CONVERT CONDUCTIVITY TO SALINITY
      R = CND
      RT = R/(RT35(T)*(1.0 + C(P)/(B(T) + A(T)*R)))
      RT = SQRT(ABS(RT))
      SAL78 = SAL(RT,DT)
      RETURN
C *********  END OF CONDUCTIVITY TO SALINITY SECTION ***********
C ***************************************************
C INVERT SALINITY TO CONDUCTIVITY BY THE
C  NEWTON-RAPHSON ITERATIVE METHOD.
C ***************************************************
C FIRST APPROXIMATION
   10 RT = SQRT(CND/35.0)
      SI = SAL(RT,DT)
      N = 0
C
C  ITERATION LOOP BEGINS HERE WITH A MAXIMUM OF 10 CYCLES
C
   15 RT = RT + (CND - SI)/DSAL(RT,DT)
      SI = SAL(RT,DT)
      N = N + 1
      DELS = ABS(SI - CND)
      IF((DELS.GT.1.0E-4).AND.(N.LT.10))GO TO 15
C
C ****************************END OF ITERATION LOOP ********
C
C COMPUTE CONDUCTIVITY RATIO
      RTT = RT35(T)*RT*RT
      AT = A(T)
      BT = B(T)
      CP = C(P)
      CP = RTT*(CP + BT)
      BT = BT - RTT*AT
C
C SOLVE QUADRATIC EQUATION FOR R: R=RT35*RT*(1+C/AR+B)
C
      R = SQRT(ABS(BT*BT + 4.0*AT*CP)) - BT
C CONDUCTIVITY RETURN
      SAL78 = 0.5*R/AT
      RETURN
      END
```

```
      REAL FUNCTION THETA(S,TO,PO,PR)
C ***********************************
C TO COMPUTE LOCAL POTENTIAL TEMPERATURE AT PR
C USING BRYDEN 1973 POLYNOMIAL FOR ADIABATIC LAPSE RATE
C AND RUNGE-KUTTA 4-TH ORDER INTEGRATION ALGORITHM.
C REF: BRYDEN,H.,1973,DEEP-SEA RES.,20,401-408
C FOFONOFF,N.,1977,DEEP-SEA RES.,24,489-491
C UNITS:
C       PRESSURE         PO       DECIBARS
C       TEMPERATURE      TO       DEG CELSIUS (IPTS-68)
C       SALINITY         S        (IPSS-78)
C       REFERENCE PRS    PR       DECIBARS
C       POTENTIAL TMP.   THETA    DEG CELSIUS
C CHECKVALUE: THETA= 36.89073 C,S=40 (IPSS-78),TO=40 DEG C,
C PO=10000 DECIBARS,PR=0 DECIBARS
C
C      SET-UP INTERMEDIATE TEMPERATURE AND PRESSURE VARIABLES
      P=PO
      T=TO
C**************
      H = PR - P
      XK = H*ATG(S,T,P)
      T = T + 0.5*XK
      Q = XK
      P = P + 0.5*H
      XK = H*ATG(S,T,P)
      T = T + 0.29289322*(XK-Q)
      Q = 0.58578644*XK + 0.121320344*Q
      XK = H*ATG(S,T,P)
      T = T + 1.707106781*(XK-Q)
      Q = 3.414213562*XK - 4.121320344*Q
      P = P + 0.5*H
      XK = H*ATG(S,T,P)
      THETA = T + (XK-2.0*Q)/6.0
      RETURN
      END
```

```
      REAL FUNCTION ATG(S,T,P)
C ****************************
C ADIABATIC TEMPERATURE GRADIENT DEG C PER DECIBAR
C REF: BRYDEN,H.,1973,DEEP-SEA RES.,20,401-408
C UNITS:
C       PRESSURE         P         DECIBARS
C       TEMPERATURE      T         DEG CELSIUS (IPTS-68)
C       SALINITY         S         (IPSS-78)
C       ADIABATIC        ATG       DEG. C/DECIBAR
C CHECKVALUE: ATG=3.255976E-4 C/DBAR FOR S=40 (IPSS-78),
C T=40 DEG C,PO=10000 DECIBARS
      DS = S - 35.0
      ATG = (((-2.1687E-16*T+1.8676E-14)*T-4.6206E-13)*P
     X+((2.7759E-12*T-1.1351E-10)*DS+((-5.4481E-14*T
     X+8.733E-12)*T-6.7795E-10)*T+1.8741E-8))*P
     X+(-4.2393E-8*T+1.8932E-6)*DS
     X+((6.6228E-10*T-6.836E-8)*T+8.5258E-6)*T+3.5803E-5
      RETURN
      END
```

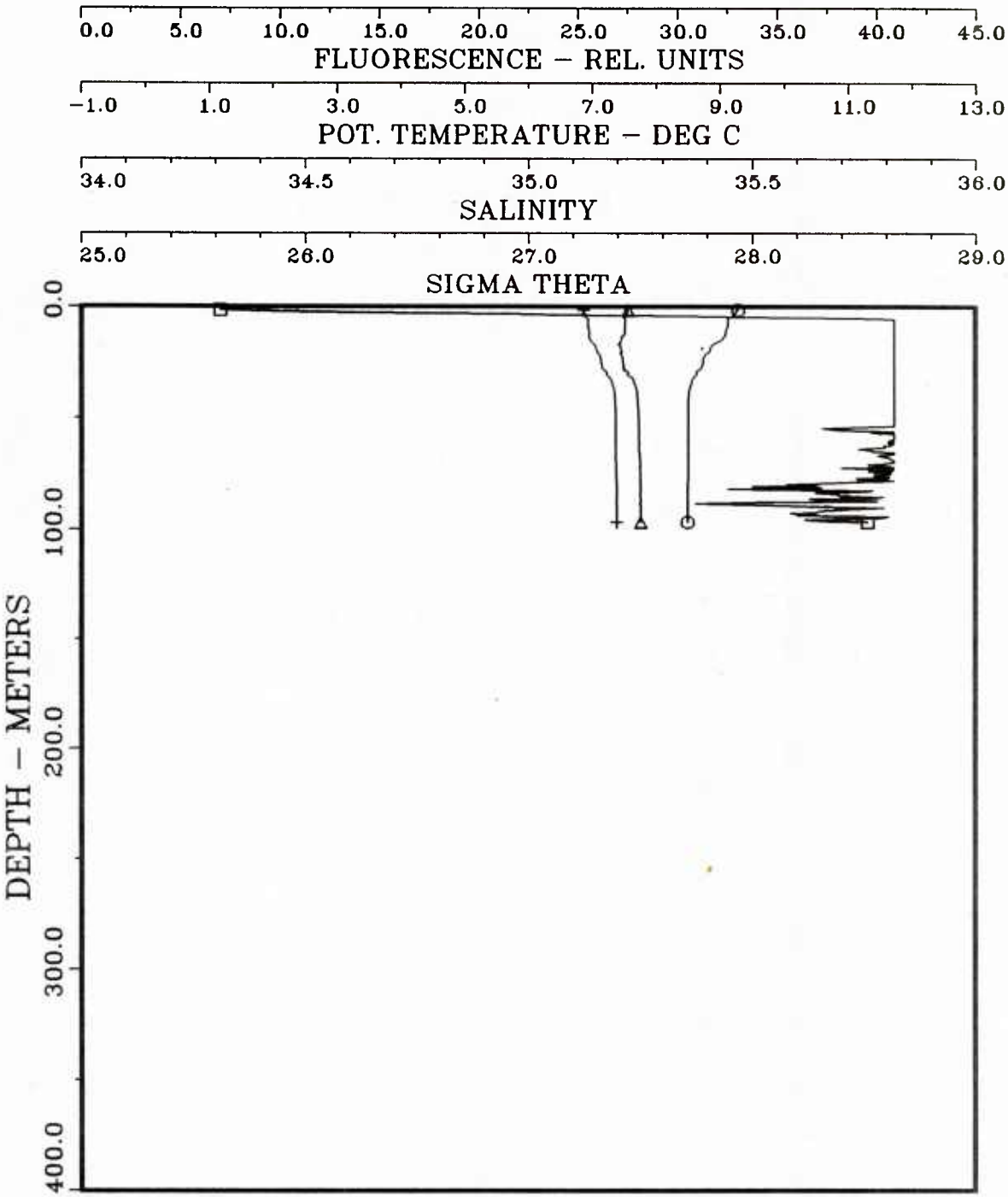
```
C *********************************
      REAL FUNCTION DEPTH(P,LAT)
C *********************************
C DEPTH IN METERS FROM PRESSURE IN DECIBARS USING
C SAUNDERS AND FOFONOFF'S METHOD.
C DEEP-SEA RES., 1976,23,109-111.
C FORMULA REFITTED FOR 1980 EQUATION OF STATE
C UNITS:
C       PRESSURE         P         DECIBARS
C       LATITUDE         LAT       DEGREES
C       DEPTH            DEPTH     METERS
C CHECKVALUE: DEPTH = 9712.653 M FOR P=10000 DECIBARS, LATITUDE=30 DEG
C     ABOVE FOR STANDARD OCEAN: T=0 DEG. CELSUIS ; S=35 (IPSS-78)
C
      REAL LAT
C
      X = SIN(LAT/57.29578)
C**************************
      X = X*X
C GR= GRAVITY VARIATION WITH LATITUDE: ANON (1970) BULLETIN GEODESIQUE
      GR = 9.780318*(1.0+(5.2788E-3+2.36E-5*X)*X) + 1.092E-6*P
      DEPTH = (((-1.82E-15*P+2.279E-10)*P-2.2512E-5)*P+9.72659)*P
      DEPTH=DEPTH/GR
      RETURN
      END
```

```
      REAL FUNCTION SVAN(S,T,PO,SIGMA)
C  MODIFIED RCM
C ***************************************************
C SPECIFIC VOLUME ANOMALY (STERIC ANOMALY) BASED ON 1980 EQUATION
C OF STATE FOR SEAWATER AND 1978 PRACTICAL SALINITY SCALE.
C REFERENCES
C MILLERO, ET AL (1980) DEEP-SEA RES.,27A,255-264
C MILLERO AND POISSON 1981,DEEP-SEA RES.,28A PP 625-629.
C BOTH ABOVE REFERENCES ARE ALSO FOUND IN UNESCO REPORT 38 (1981)
C UNITS:
C       PRESSURE         PO       DECIBARS
C       TEMPERATURE      T        DEG CELSIUS (IPTS-68)
C       SALINITY         S        (IPSS-78)
C       SPEC. VOL. ANA.  SVAN     M**3/KG *1.0E-8
C       DENSITY ANA.     SIGMA    KG/M**3
C ***************************************************************
C CHECK VALUE: SVAN=981.3021 E-8 M**3/KG.  FOR S = 40 (IPSS-78) ,
C T = 40 DEG C, PO= 10000 DECIBARS.
C CHECK VALUE: SIGMA = 59.82037  KG/M**3 FOR S = 40 (IPSS-78) ,
C T = 40 DEG C, PO= 10000 DECIBARS.
C ***************************************************
      REAL P,T,S,SIG,SR,R1,R2,R3,R4
      REAL A,B,C,D,E,A1,B1,AW,BW,K,KO,KW,K35
C EQUIV
      EQUIVALENCE (E,D,B1),(BW,B,R3),(C,A1,R2)
      EQUIVALENCE (AW,A,R1),(KW,KO,K)
C ********************
C DATA
      DATA R3500,R4/1028.1063,4.8314E-4/
      DATA DR350/28.106331/
C   R4 IS REFERED TO AS  C  IN MILLERO AND POISSON 1981
C CONVERT PRESSURE TO BARS AND TAKE SQUARE ROOT SALINITY.
      P=PO/10.
      SR = SQRT(ABS(S))
C ***********************************************************
C PURE WATER DENSITY AT ATMOSPHERIC PRESSURE
C   BIGG P.H.,(1967) BR. J. APPLIED PHYSICS 8 PP 521-537.
C
      R1 = ((((6.536332E-9*T-1.120083E-6)*T+1.001685E-4)*T
     X-9.095290E-3)*T+6.793952E-2)*T-28.263737
C SEAWATER DENSITY ATM PRESS.
C  COEFFICIENTS INVOLVING SALINITY
C  R2 = A   IN NOTATION OF MILLERO AND POISSON 1981
      R2 = (((5.3875E-9*T-8.2467E-7)*T+7.6438E-5)*T-4.0899E-3)*T
     X+8.24493E-1
C  R3 = B  IN NOTATION OF MILLERO AND POISSON 1981
      R3 = (-1.6546E-6*T+1.0227E-4)*T-5.72466E-3
C  INTERNATIONAL ONE-ATMOSPHERE EQUATION OF STATE OF SEAWATER
      SIG = (R4*S + R3*SR + R2)*S + R1
C SPECIFIC VOLUME AT ATMOSPHERIC PRESSURE
      V350P = 1.0/R3500
      SVA = -SIG*V350P/(R3500+SIG)
      SIGMA=SIG+DR350
```

```
C  SCALE SPECIFIC VOL. ANAMOLY TO NORMALLY REPORTED UNITS
      SVAN=SVA*1.0E+8
      IF(P.EQ.0.0) RETURN
C ***********************************************************************
C ******  NEW HIGH PRESSURE EQUATION OF STATE FOR SEAWATER ********
C ***********************************************************************
C        MILLERO, ET AL , 1980 DSR 27A, PP 255-264
C              CONSTANT NOTATION FOLLOWS ARTICLE
C*****************************************************
C COMPUTE COMPRESSION TERMS
      E = (9.1697E-10*T+2.0816E-8)*T-9.9348E-7
      BW = (5.2787E-8*T-6.12293E-6)*T+3.47718E-5
      B = BW + E*S
C
      D = 1.91075E-4
      C = (-1.6078E-6*T-1.0981E-5)*T+2.2838E-3
      AW = ((-5.77905E-7*T+1.16092E-4)*T+1.43713E-3)*T
     X-0.1194975
      A = (D*SR + C)*S + AW
C
      B1 = (-5.3009E-4*T+1.6483E-2)*T+7.944E-2
      A1 = ((-6.1670E-5*T+1.09987E-2)*T-0.603459)*T+54.6746
      KW = (((-5.155288E-5*T+1.360477E-2)*T-2.327105)*T
     X+148.4206)*T-1930.06
      KO = (B1*SR + A1)*S + KW
C EVALUATE PRESSURE POLYNOMIAL
C ************************************************
C   K EQUALS THE SECANT BULK MODULUS OF SEAWATER
C   DK=K(S,T,P)-K(35,0,P)
C  K35=K(35,0,P)
C ************************************************
      DK = (B*P + A)*P + KO
      K35  = (5.03217E-5*P+3.359406)*P+21582.27
      GAM=P/K35
      PK = 1.0 - GAM
      SVA = SVA*PK + (V35OP+SVA)*P*DK/(K35*(K35+DK))
C  SCALE SPECIFIC VOL. ANAMOLY TO NORMALLY REPORTED UNITS
      SVAN=SVA*1.0E+8
      V35OP = V35OP*PK
C  ***************************************************
C COMPUTE DENSITY ANAMOLY WITH RESPECT TO 1000.0 KG/M**3
C  1) DR35O: DENSITY ANAMOLY AT 35 (IPSS-78), O DEG. C AND O DECIBARS
C  2) DR35P: DENSITY ANAMOLY 35 (IPSS-78), O DEG. C ,  PRES. VARIATION
C  3) DVAN : DENSITY ANAMOLY VARIATIONS INVOLVING SPECFIC VOL. ANAMOLY
C ***********************************************************************
C CHECK VALUE: SIGMA = 59.82037  KG/M**3 FOR S = 40 (IPSS-78),
C T = 40 DEG C, PO= 10000 DECIBARS.
C ***************************************************
      DR35P=GAM/V35OP
      DVAN=SVA/(V35OP*(V35OP+SVA))
      SIGMA=DR35O+DR35P-DVAN
      RETURN
      END
```

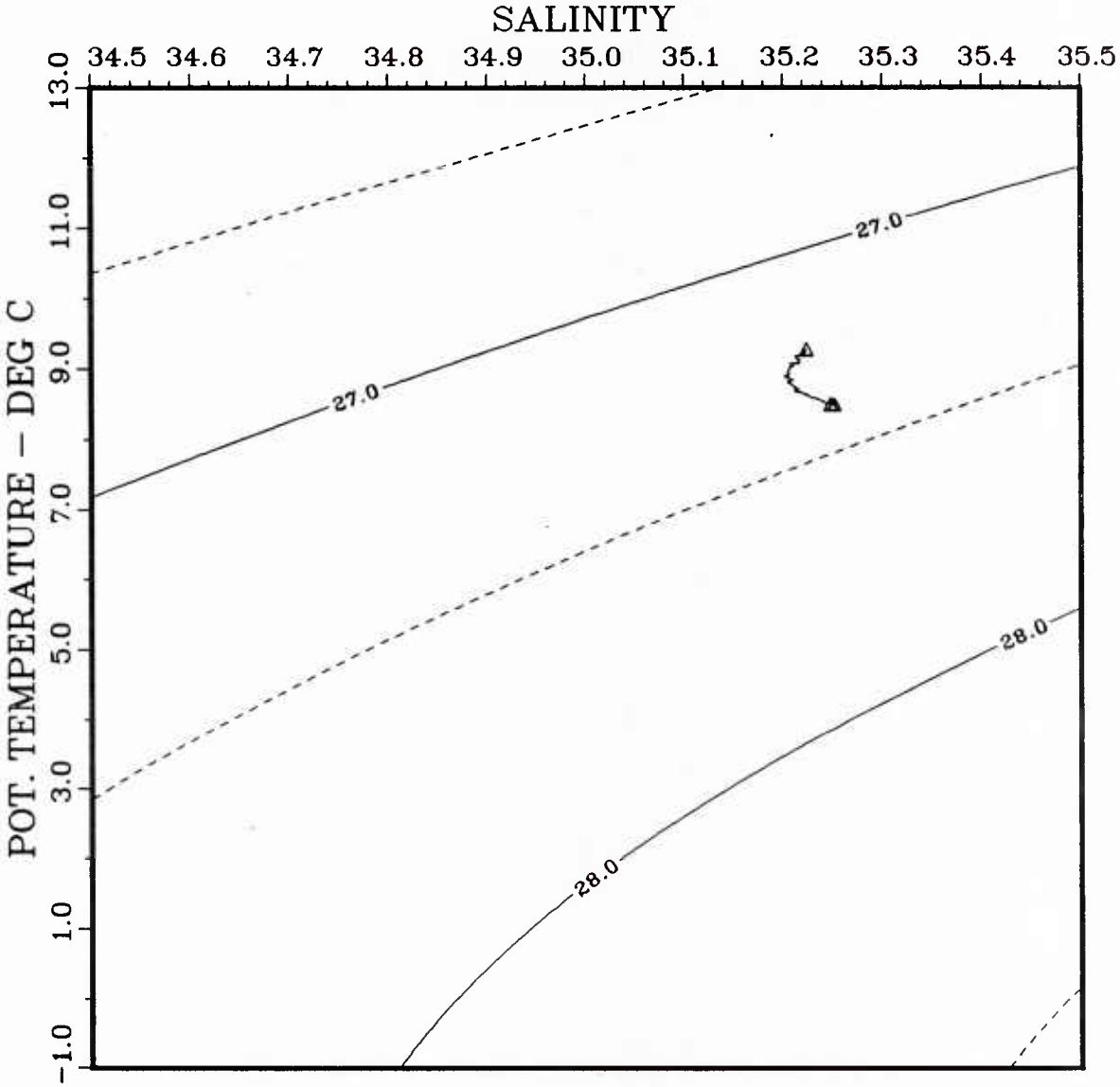
# APPENDIX B

# CTD DATA PLOTS




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 1 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 154.1940 | |
| LATITUDE | 60 14.26N | |
| LONGITUDE | 002 25.83W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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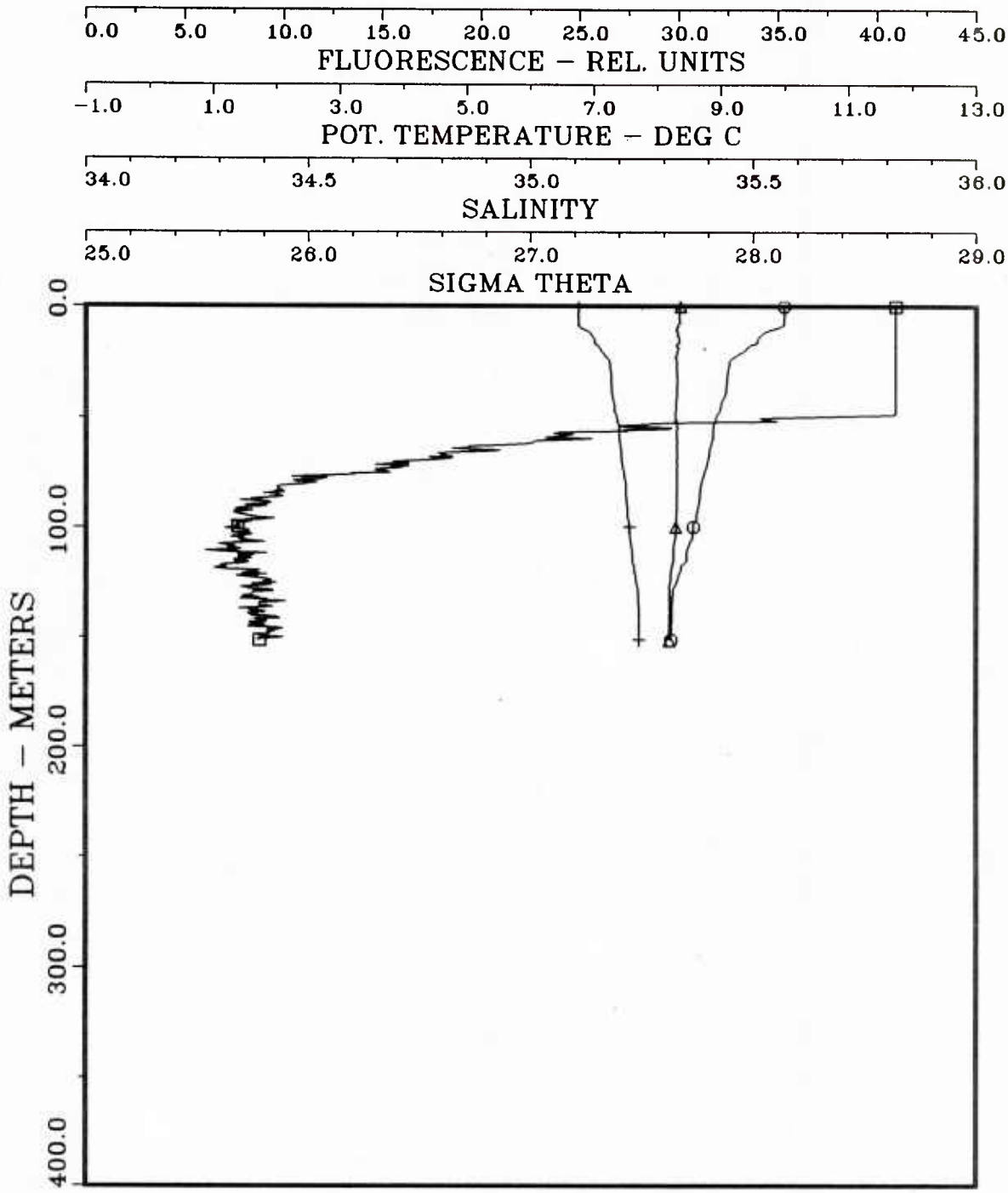
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 1 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 154.1940 | |
| LATITUDE | 60 14.26N | |
| LONGITUDE | 002 25.83W | |




| | | |
|---|---|---|
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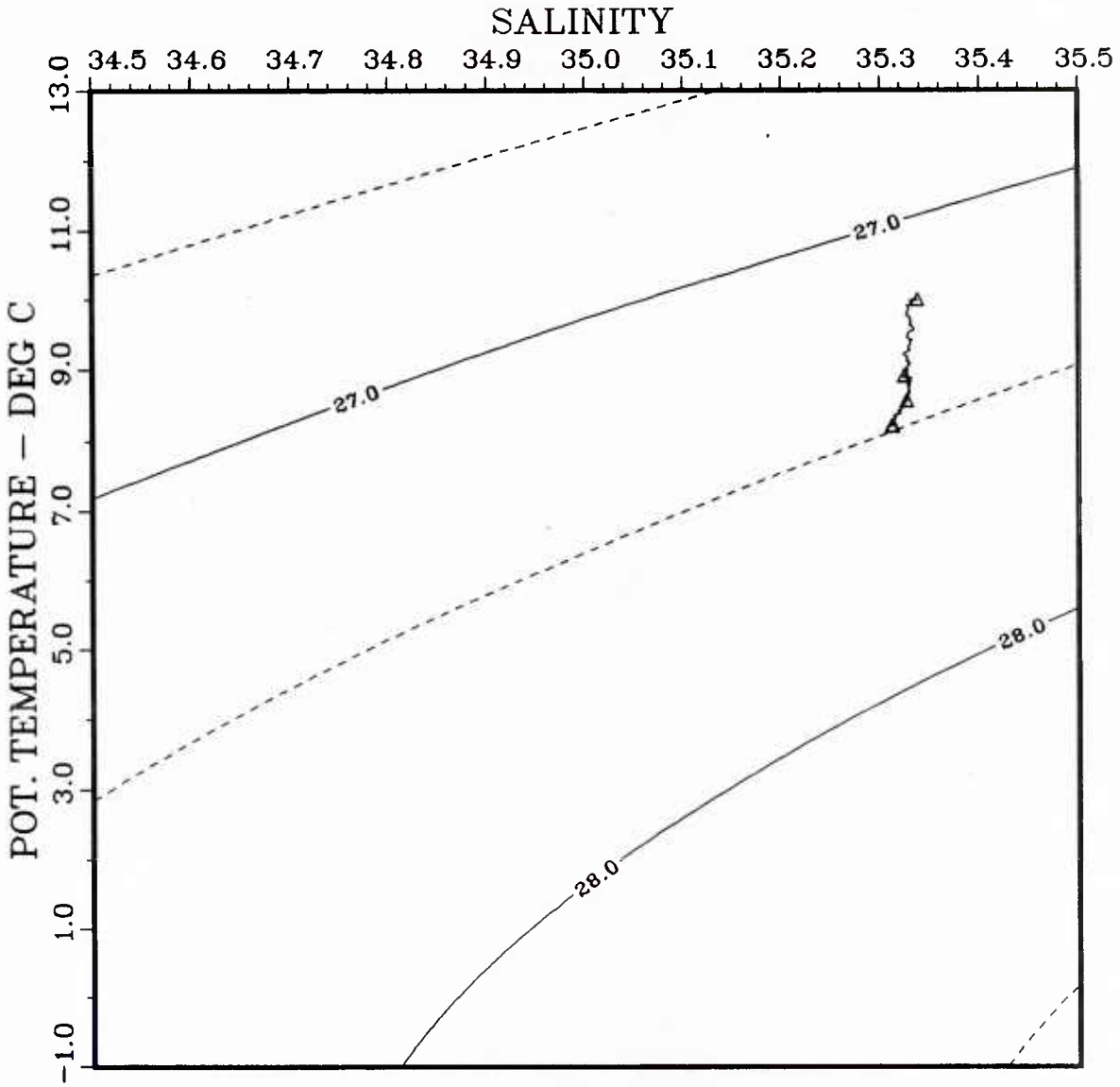
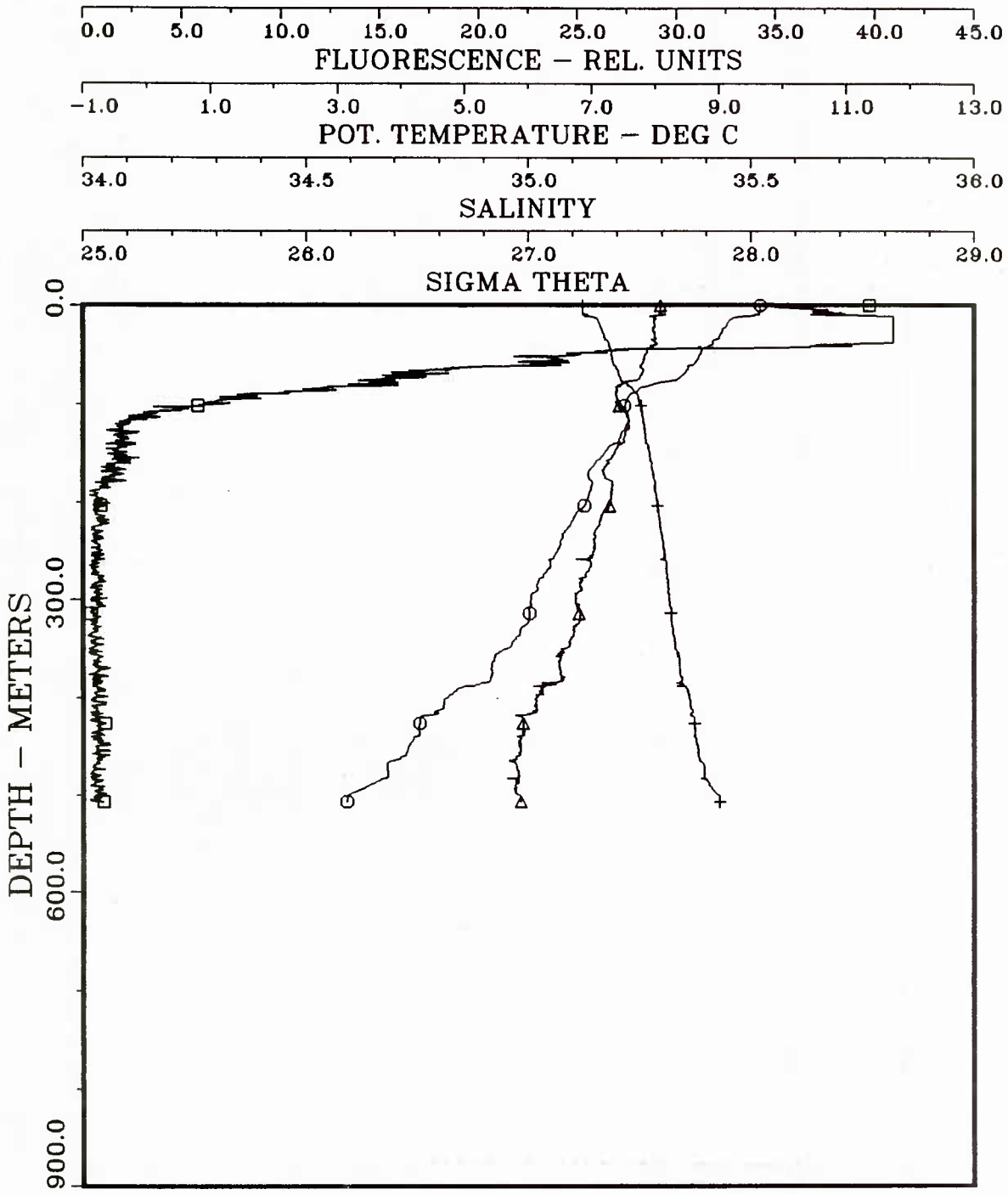
| STATION | 2 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 154.2140 | |
| LATITUDE | 60 29.01N | |
| LONGITUDE | 002 51.50W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 2 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 154.2140 | |
| LATITUDE | 60 29.01N | |
| LONGITUDE | 002 51.50W | |

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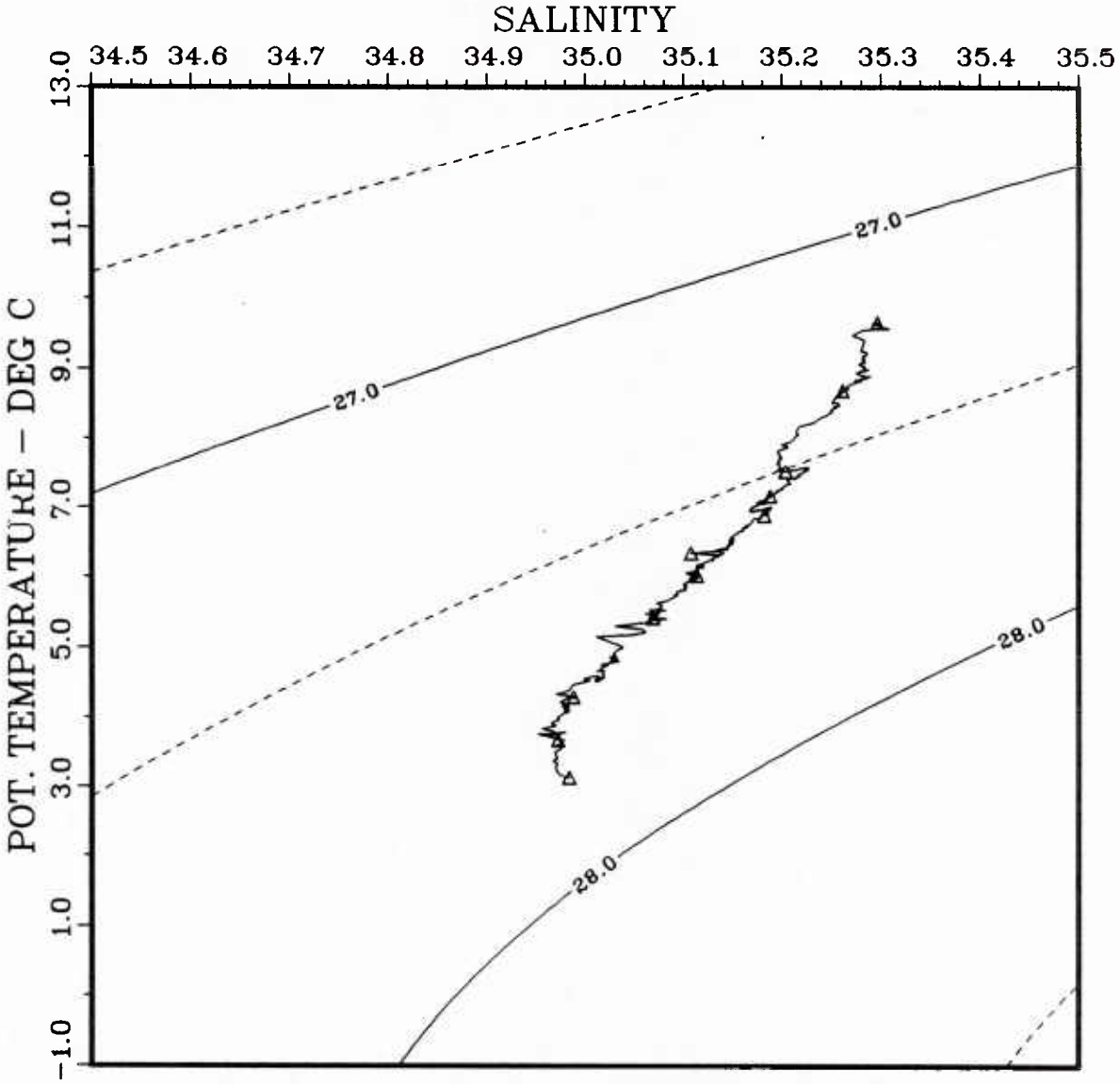
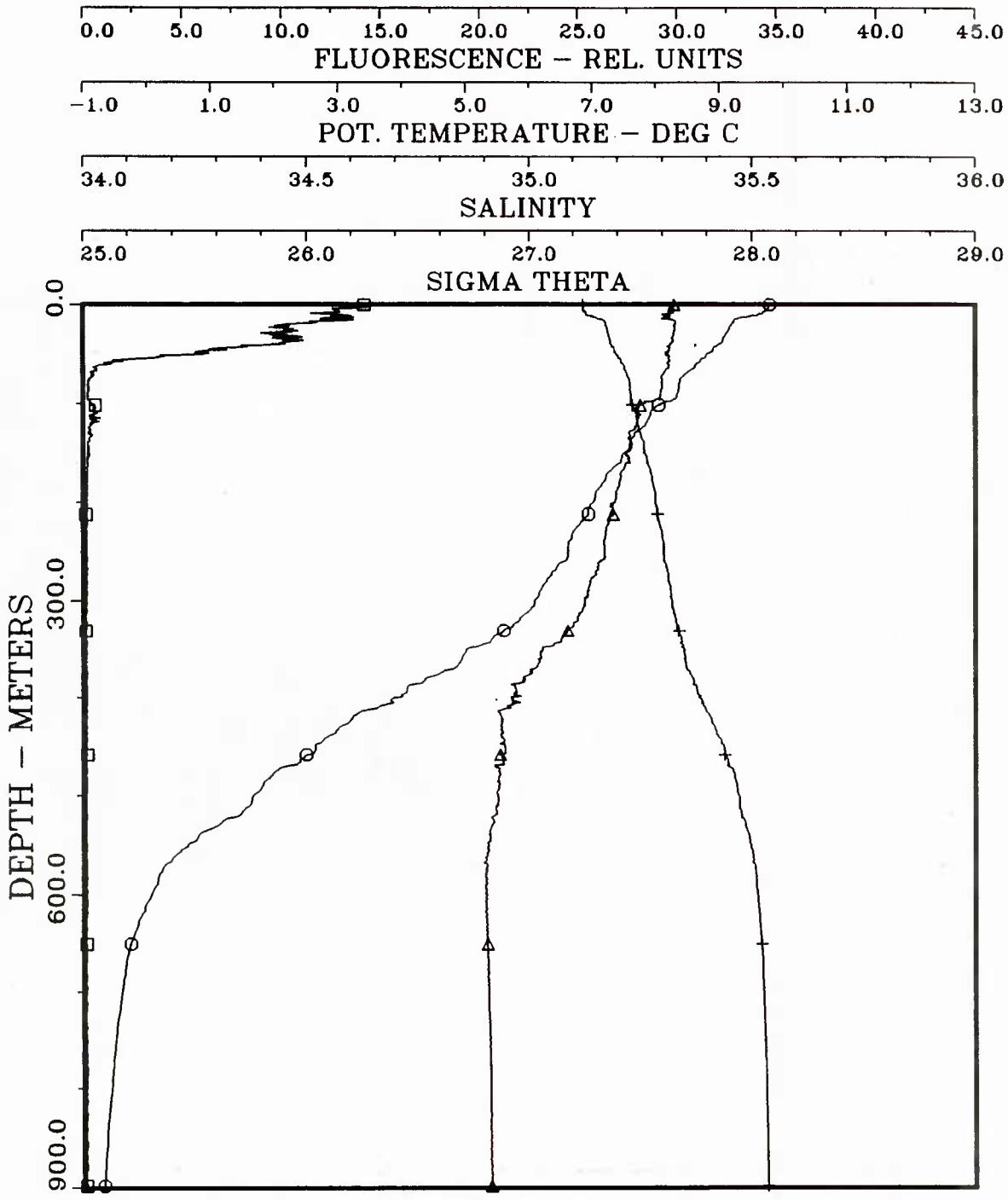
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 3 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 154.2350 | |
| LATITUDE | 60 44.64N | |
| LONGITUDE | 003 18.67W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 3 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 154.2350 | |
| LATITUDE | 60 44.64N | |
| LONGITUDE | 003 18.67W | |

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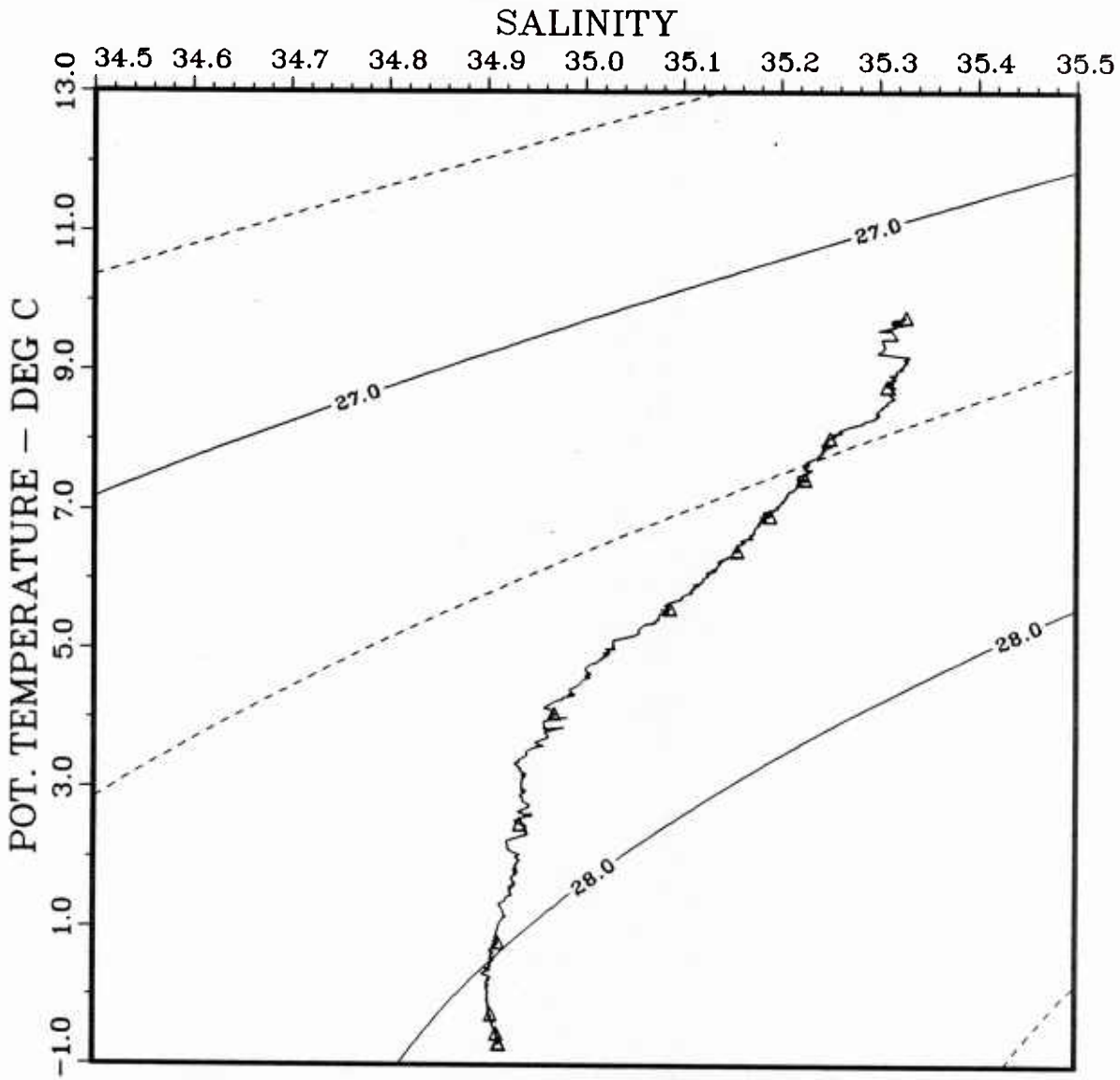
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 4 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0150 | |
| LATITUDE | 60 59.53N | |
| LONGITUDE | 003 45.10W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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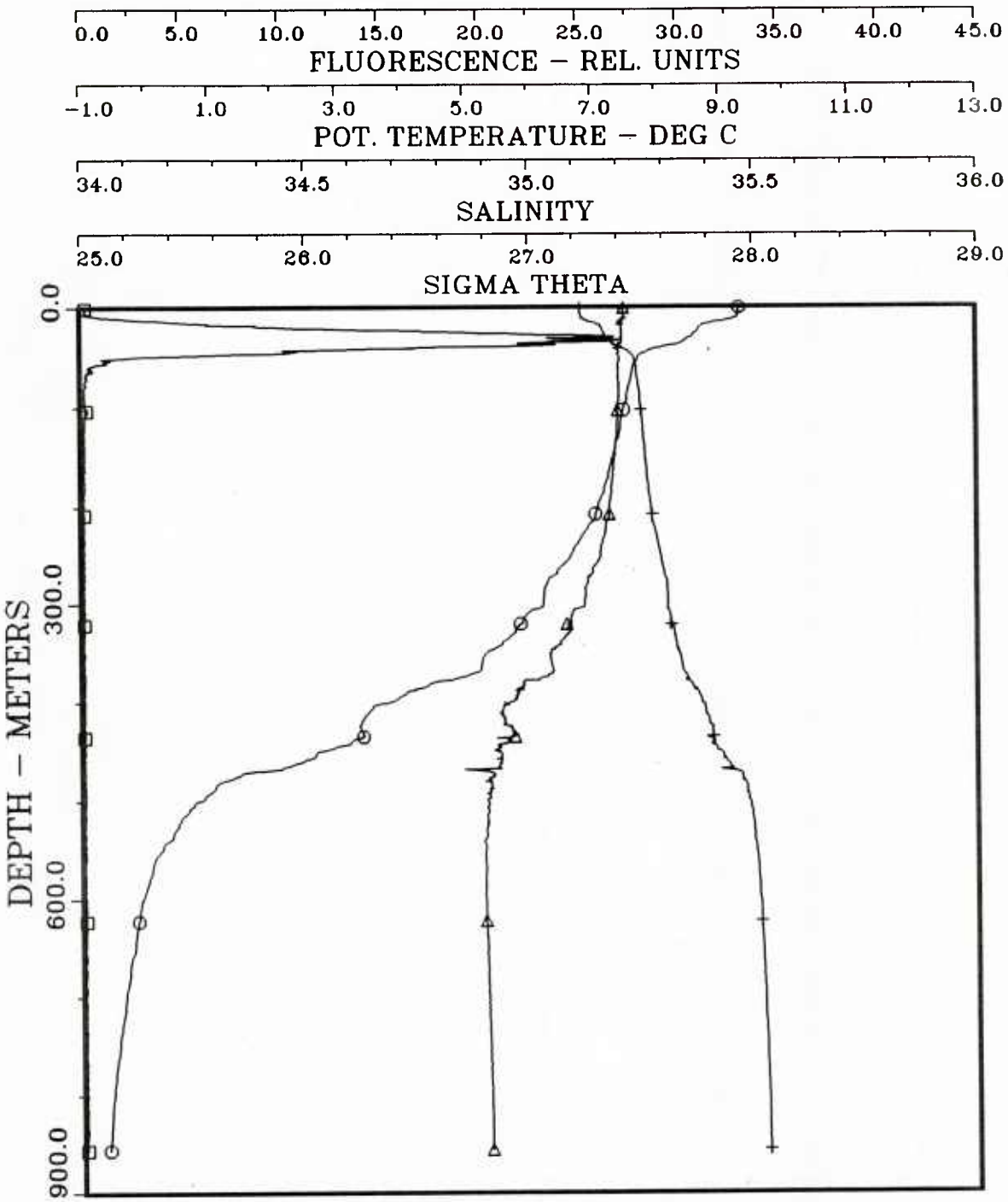
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 4 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0150 | |
| LATITUDE | 60 59.53N | |
| LONGITUDE | 003 45.10W | |

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|---|---|---|
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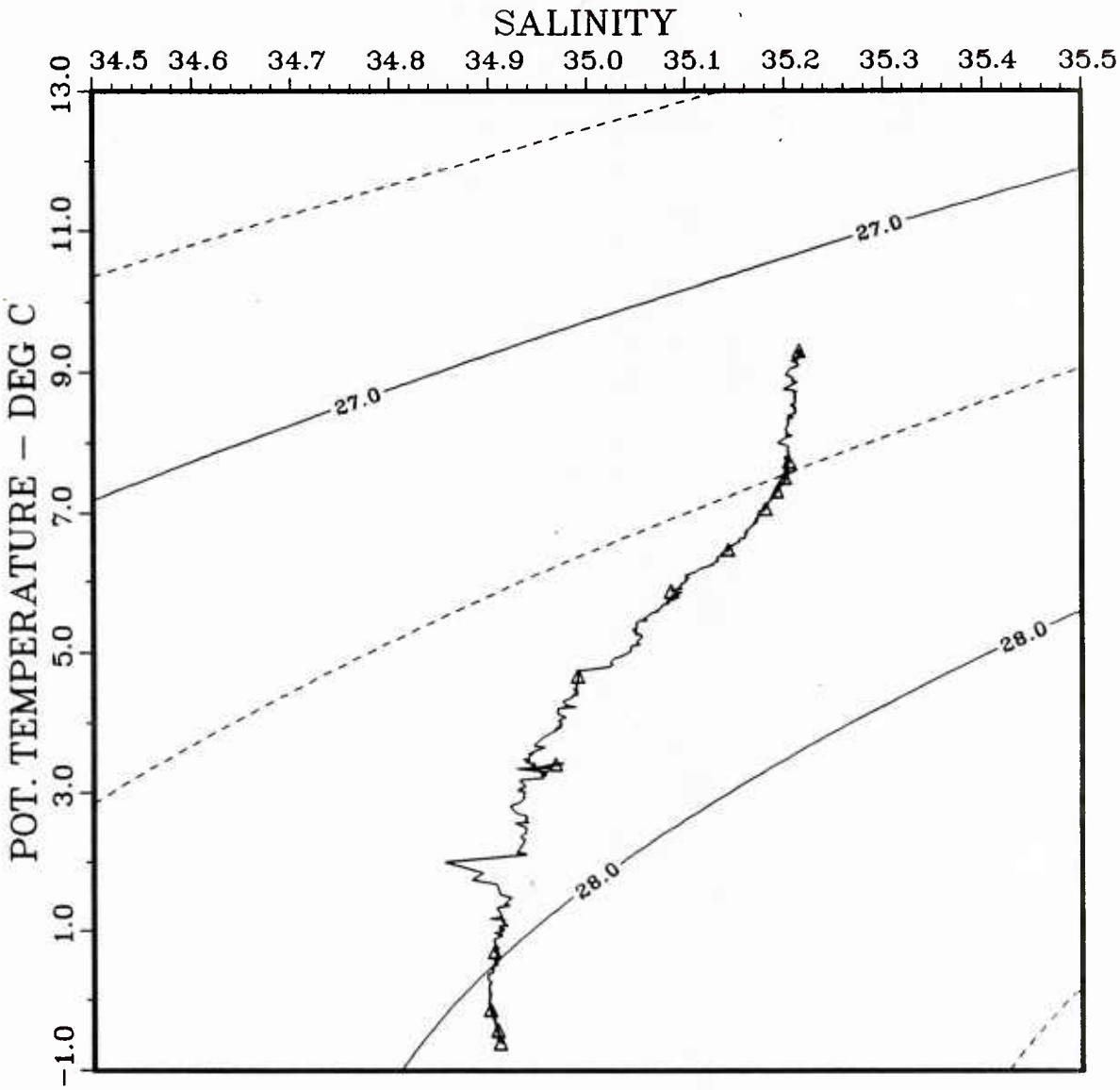
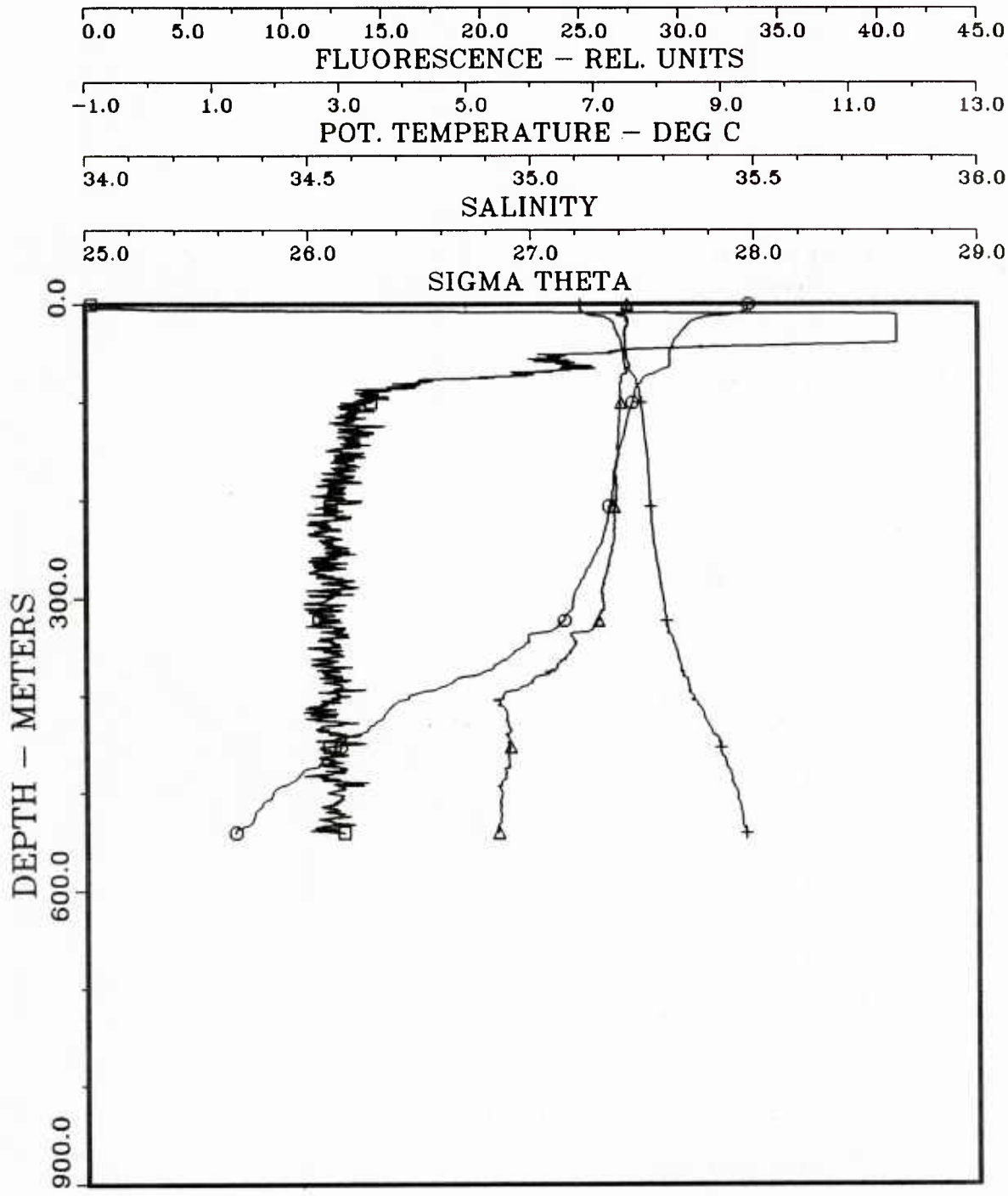
| STATION | 5 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0420 | |
| LATITUDE | 61 14.54N | |
| LONGITUDE | 004 11.49W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

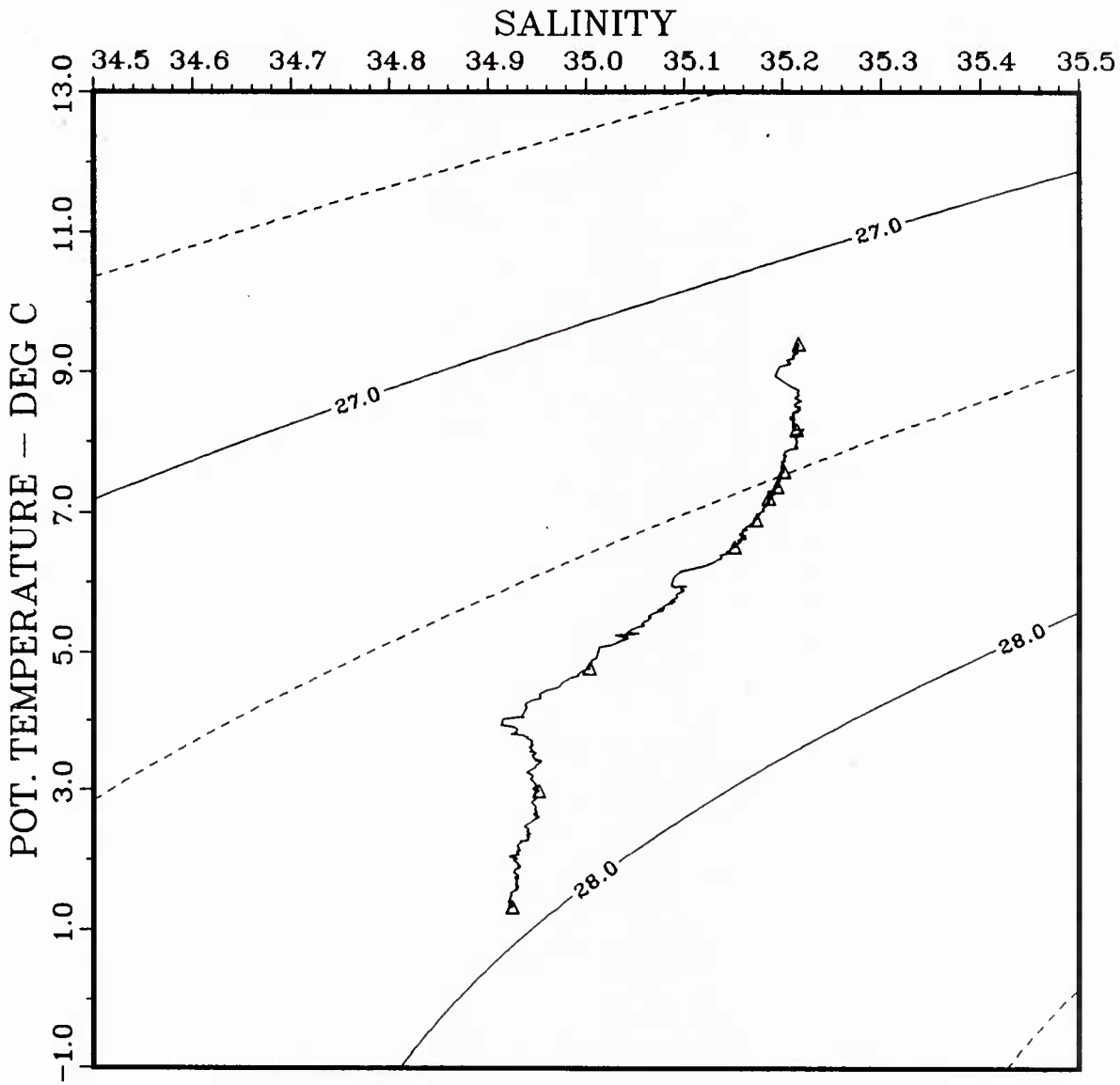



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 5 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0420 | |
| LATITUDE | 61 14.54N | |
| LONGITUDE | 004 11.49W | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 6 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0650 | |
| LATITUDE | 61 29.44N | |
| LONGITUDE | 004 37.71W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 6 | |
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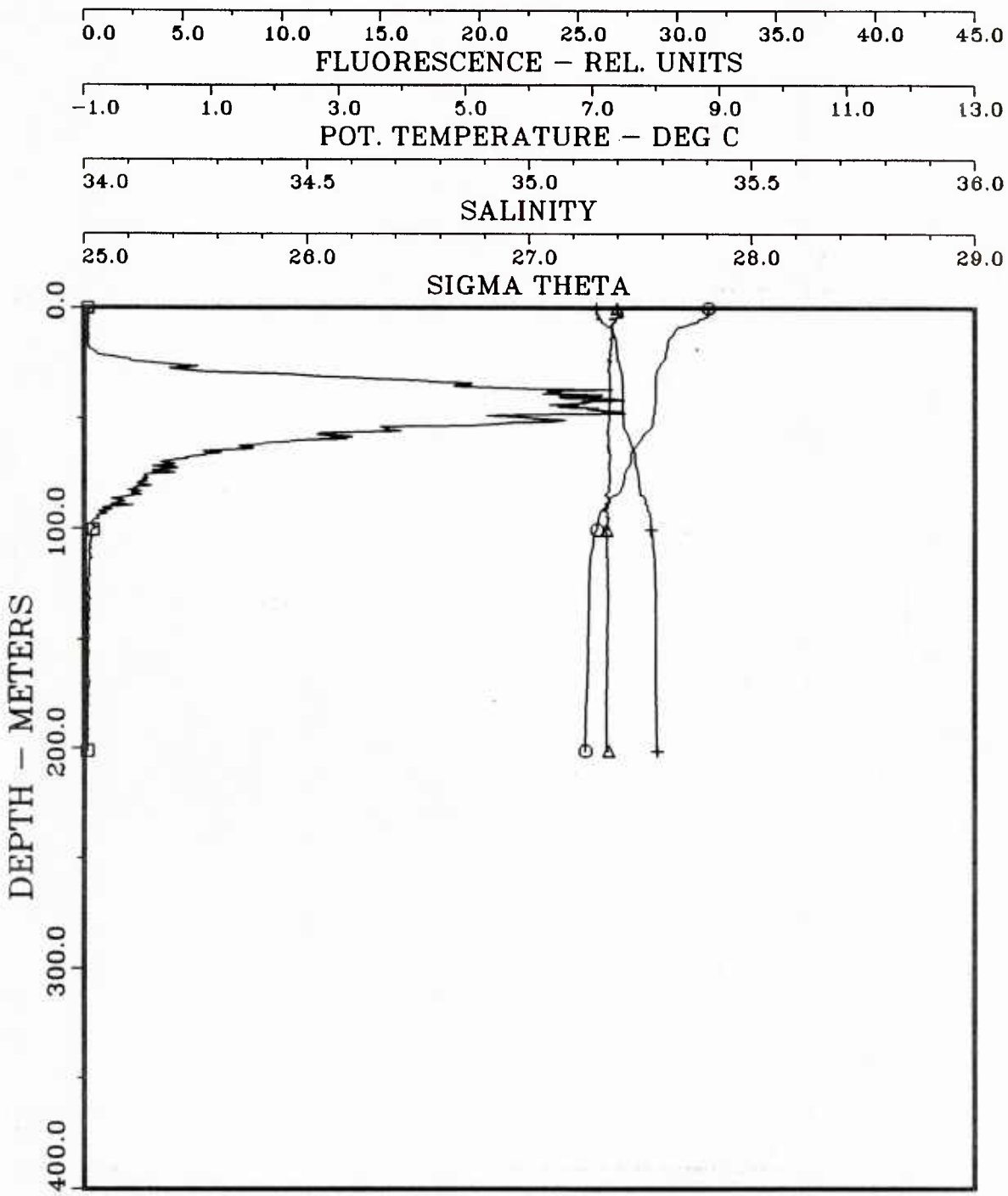
| JULIAN DATE | 155.0650 | |
| LATITUDE | 61 29.44N | |
| LONGITUDE | 004 37.71W | |

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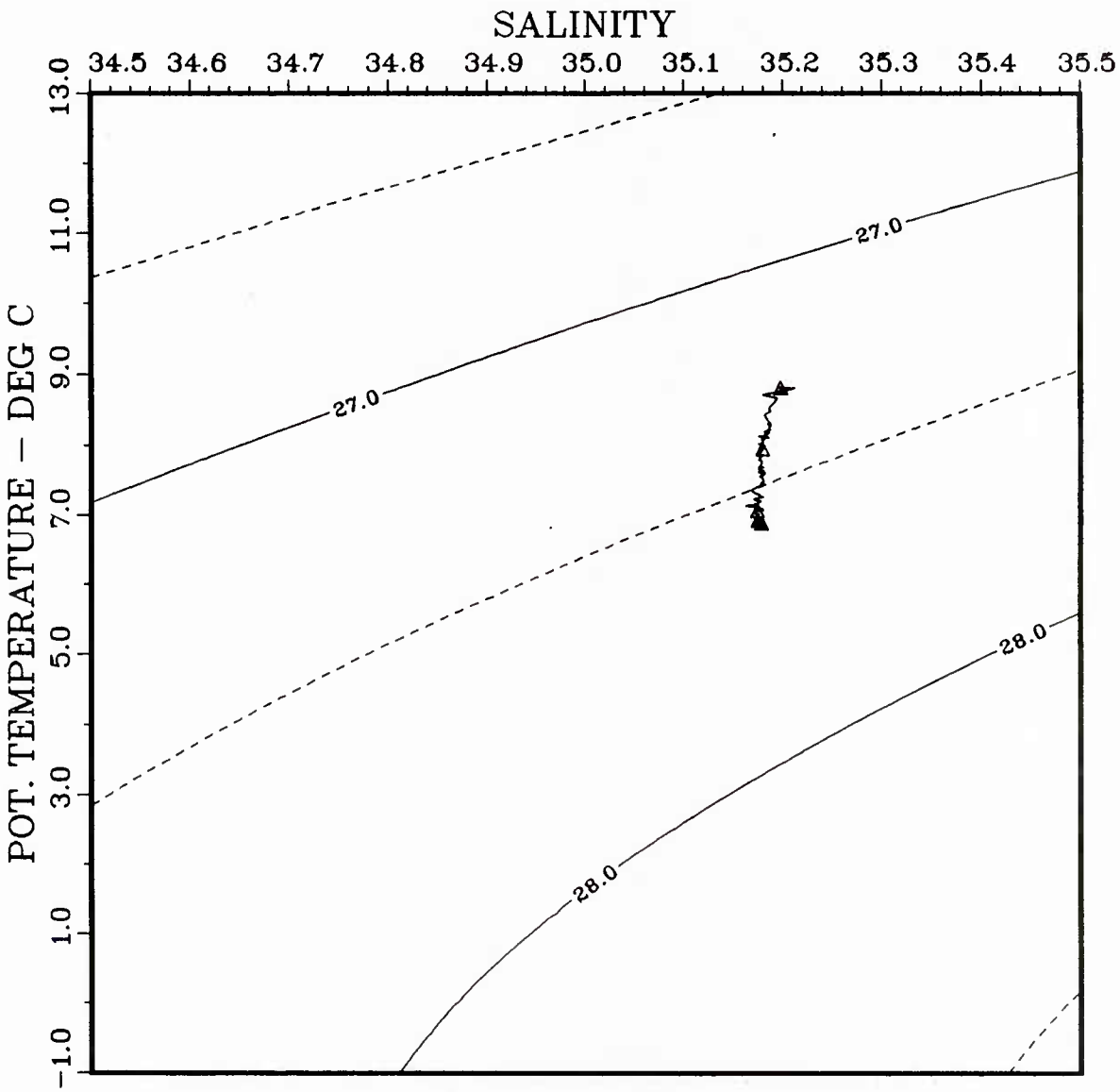
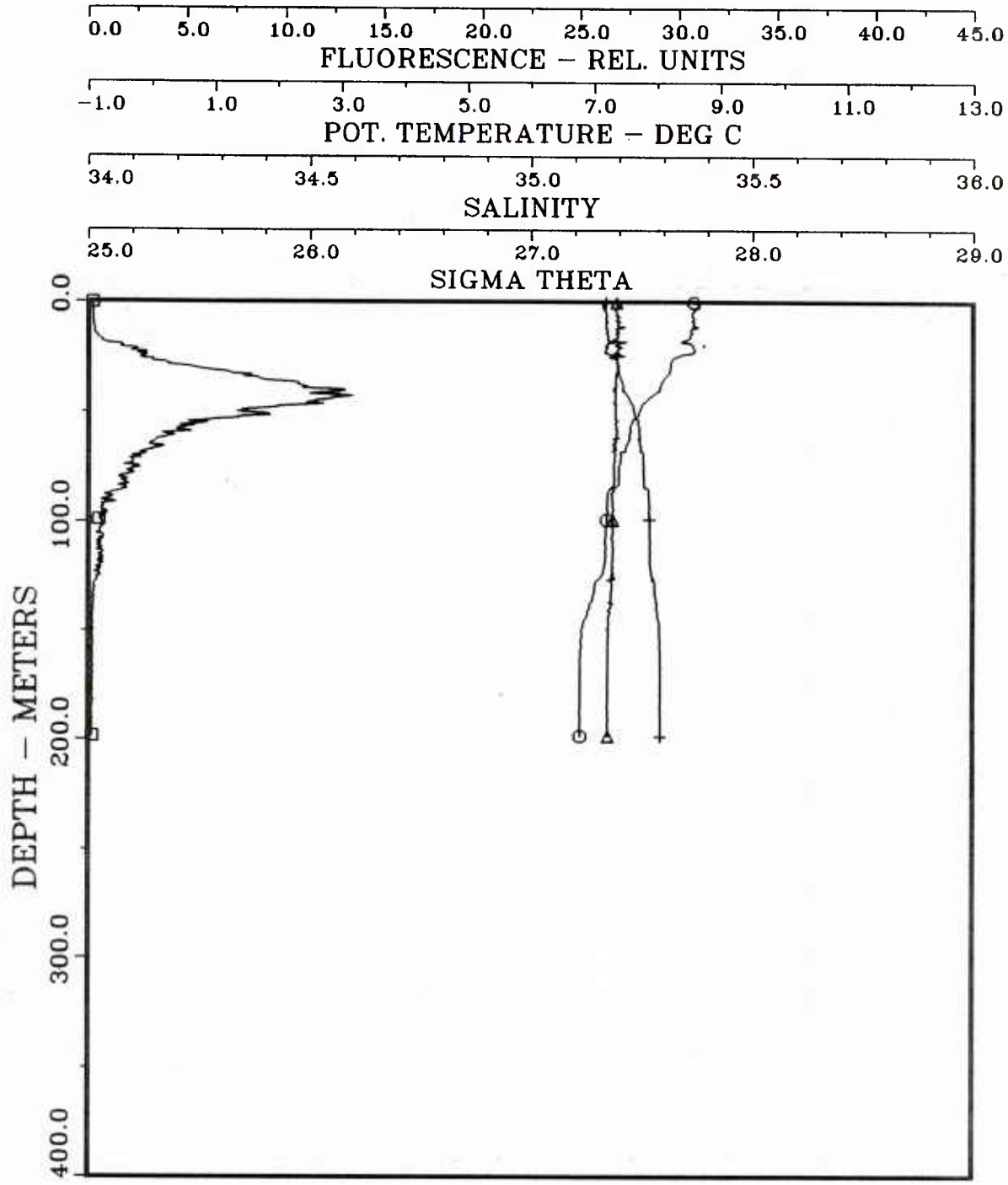
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 7 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0900 | |
| LATITUDE | 61 44.13N | |
| LONGITUDE | 005 04.05W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

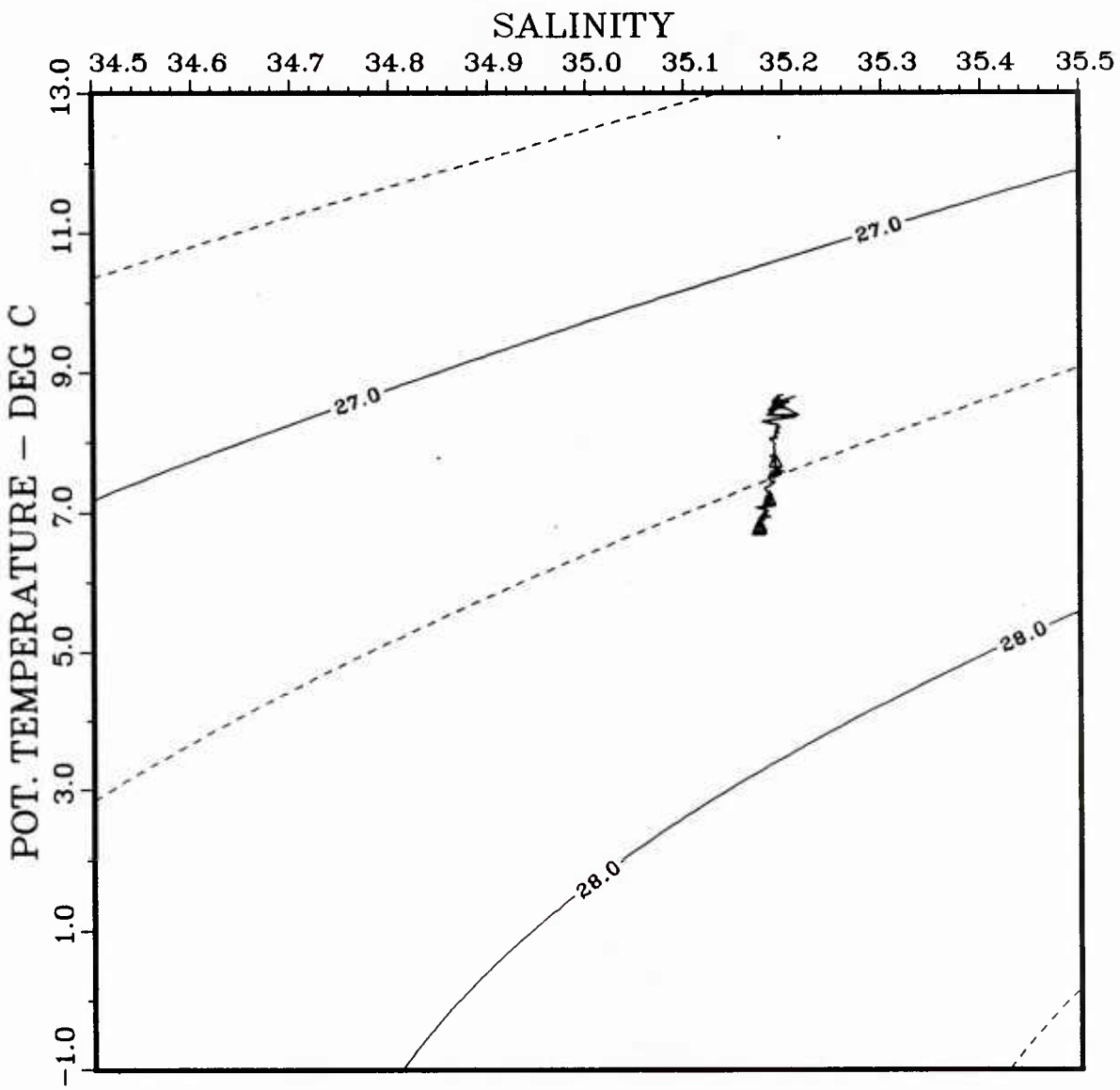



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 7 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.0900 | |
| LATITUDE | 61 44.13N | |
| LONGITUDE | 005 04.05W | |

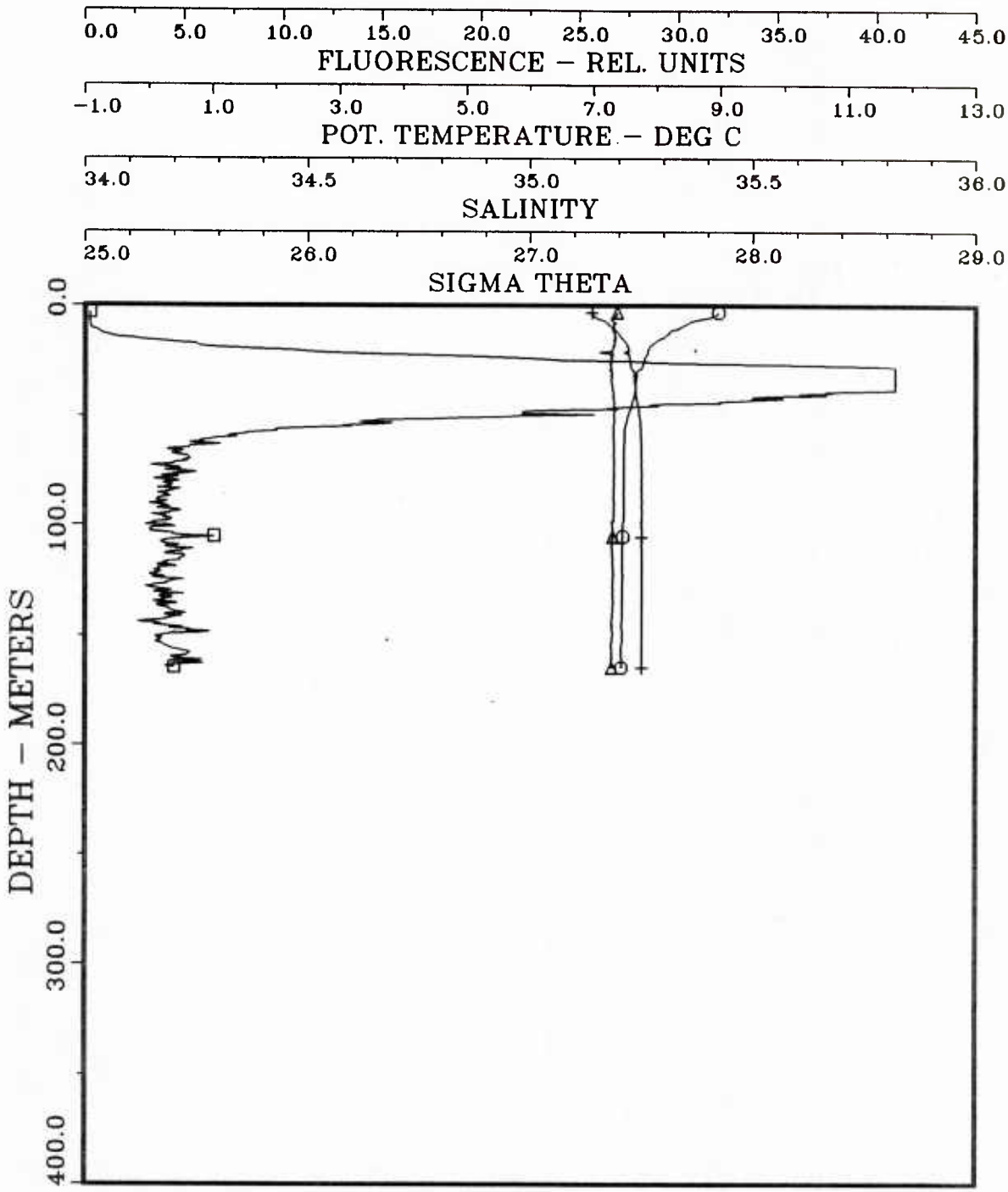



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 8 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.1110 | |
| LATITUDE | 61 59.04N | |
| LONGITUDE | 005 30.15W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

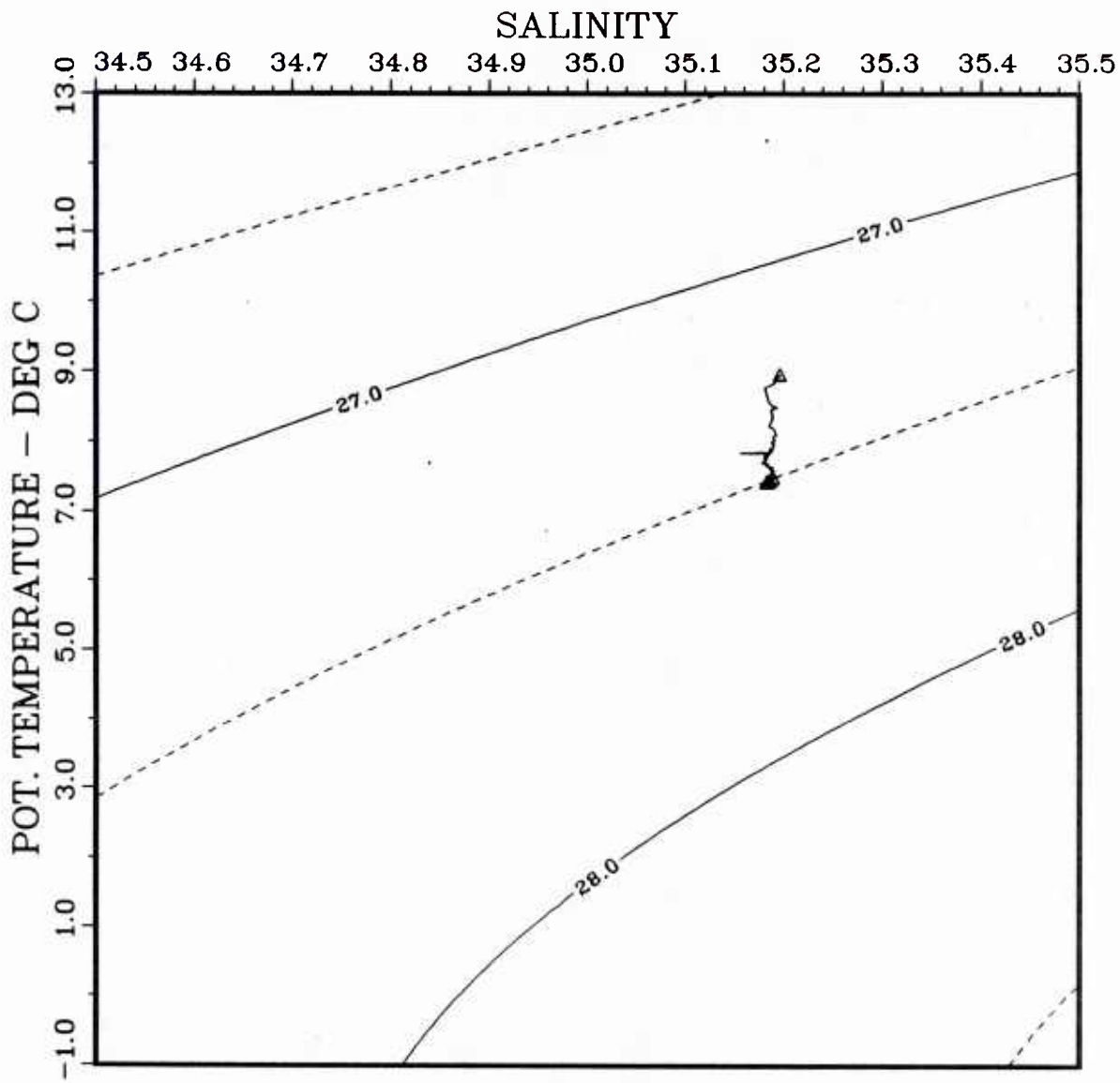



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 8 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.1110 | |
| LATITUDE | 61 59.04N | |
| LONGITUDE | 005 30.15W | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 9 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.1610 | |
| LATITUDE | 62 39.47N | |
| LONGITUDE | 006 50.05W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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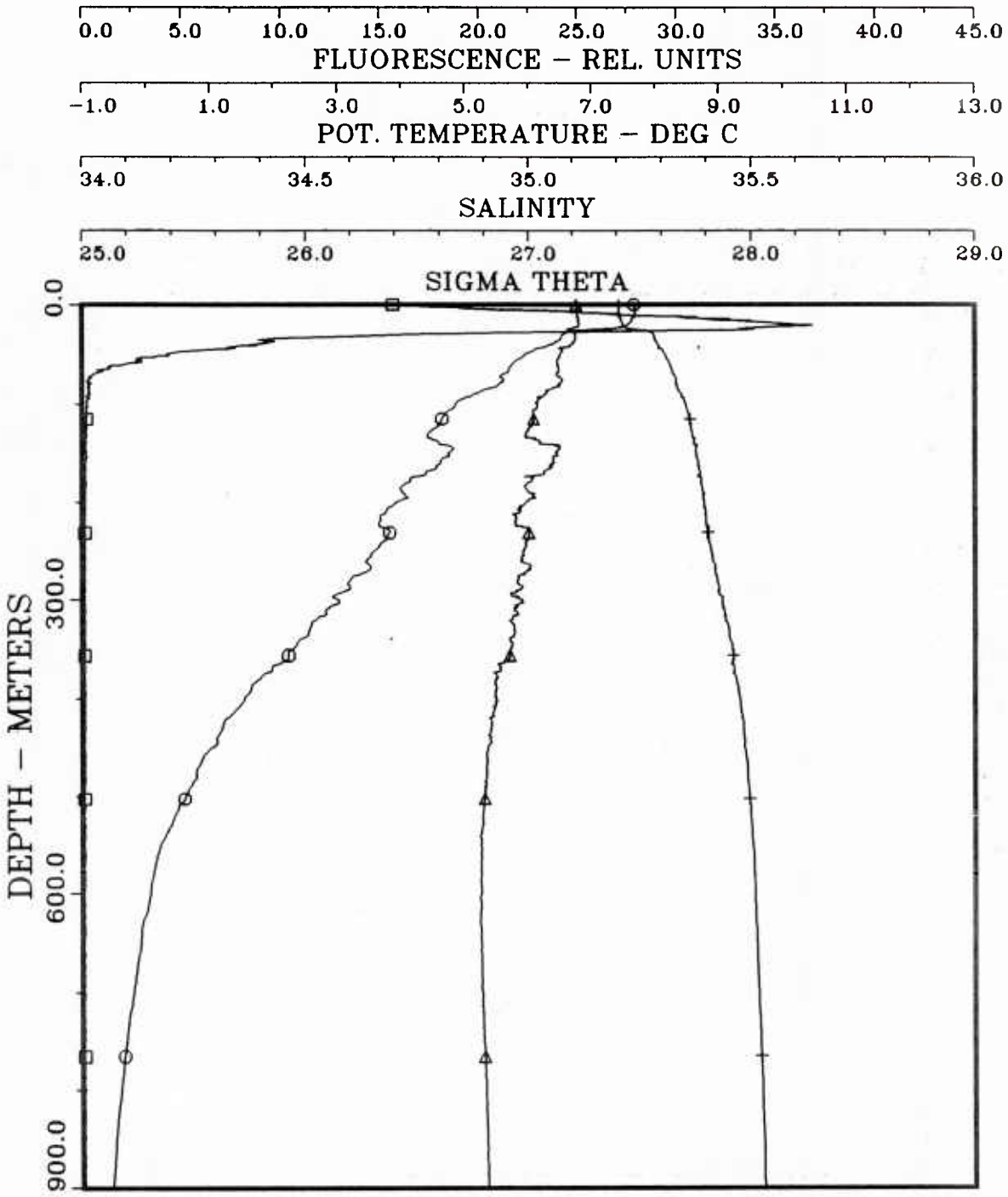
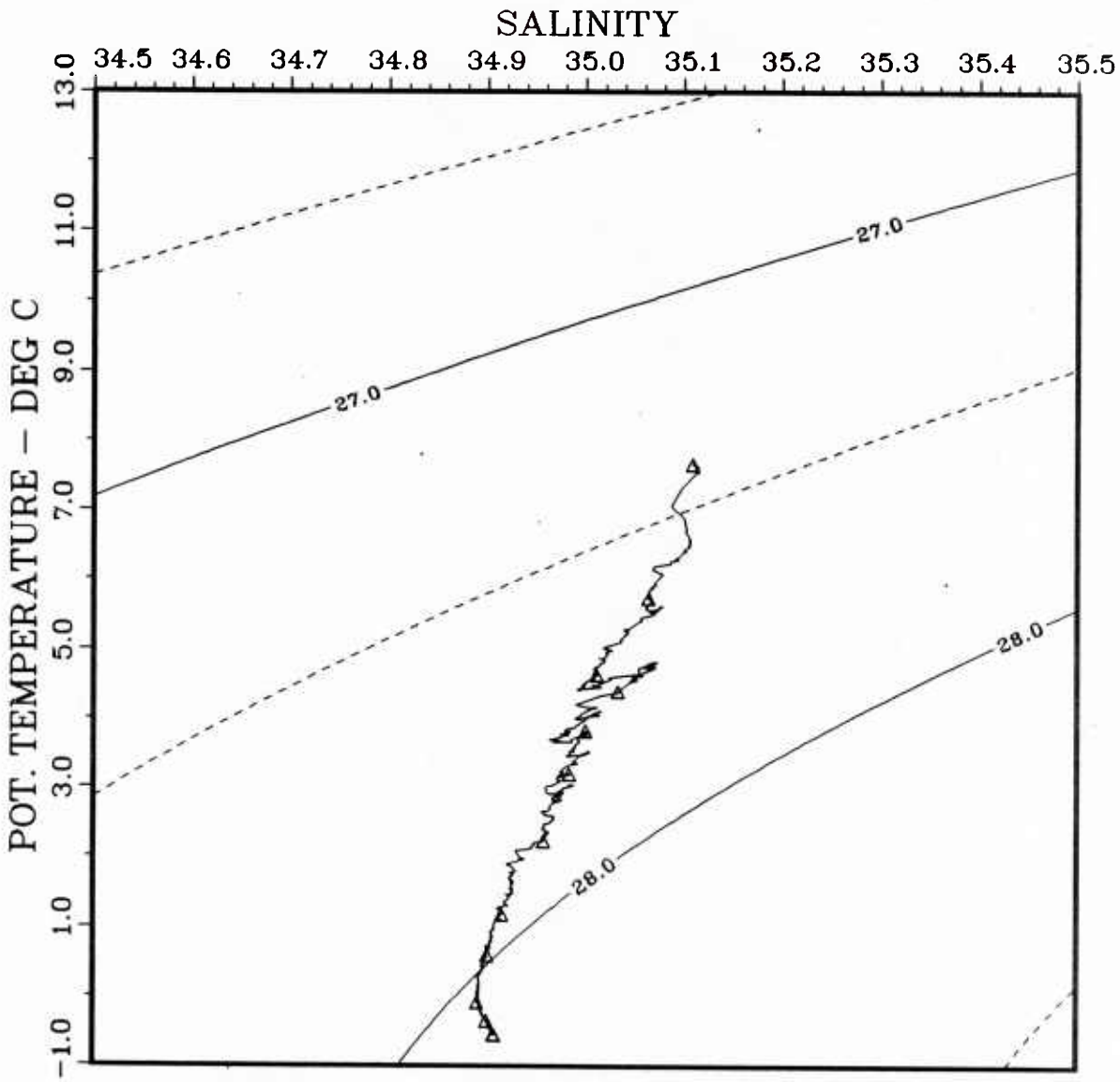
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 9 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 155.1610 | |
| LATITUDE | 62 39.47N | |
| LONGITUDE | 006 50.05W | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 10 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 157.1440 | |
| LATITUDE | 65 48.61N | |
| LONGITUDE | 001 30.59W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 10 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 157.1440 | |
| LATITUDE | 65 48.61N | |
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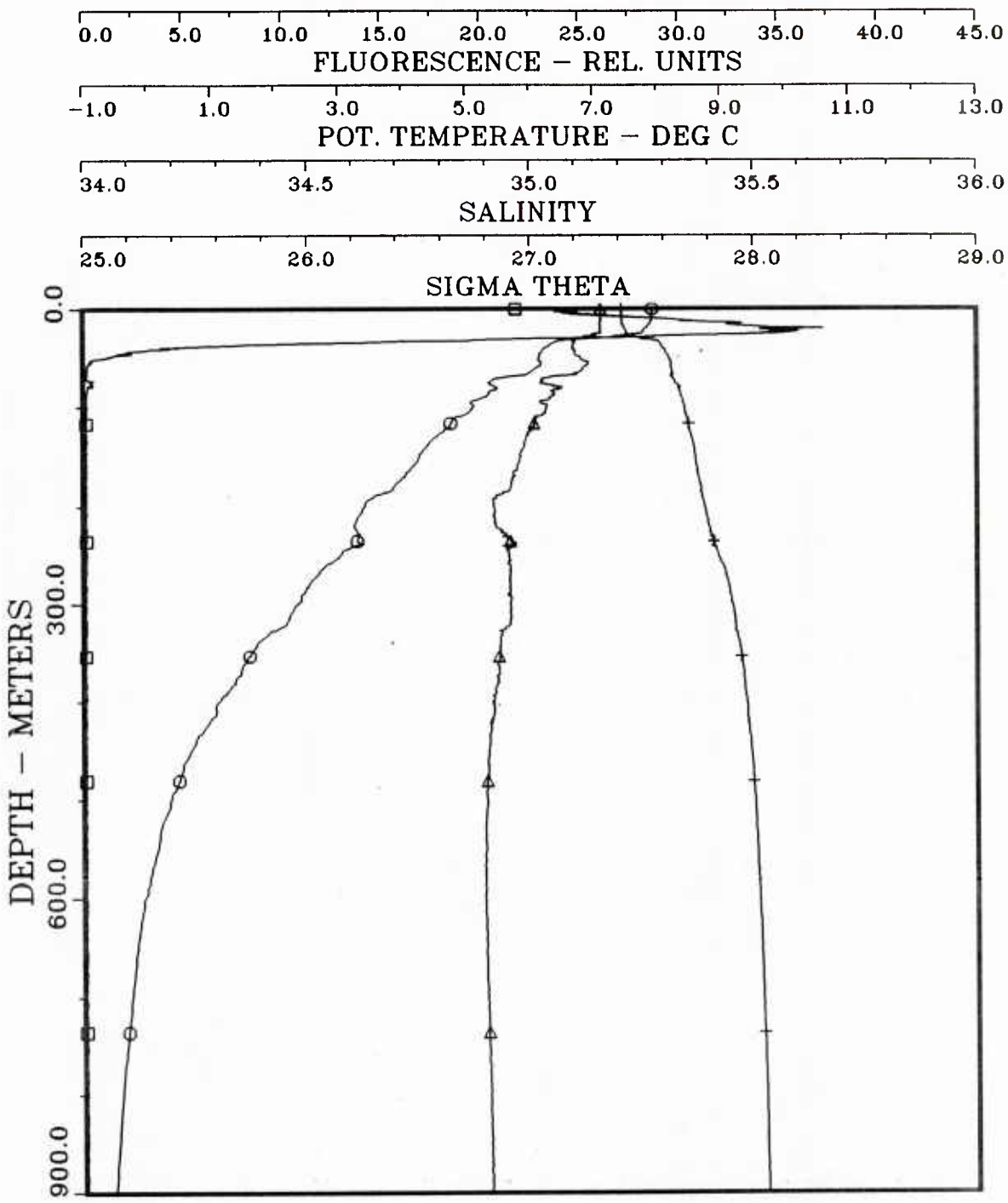
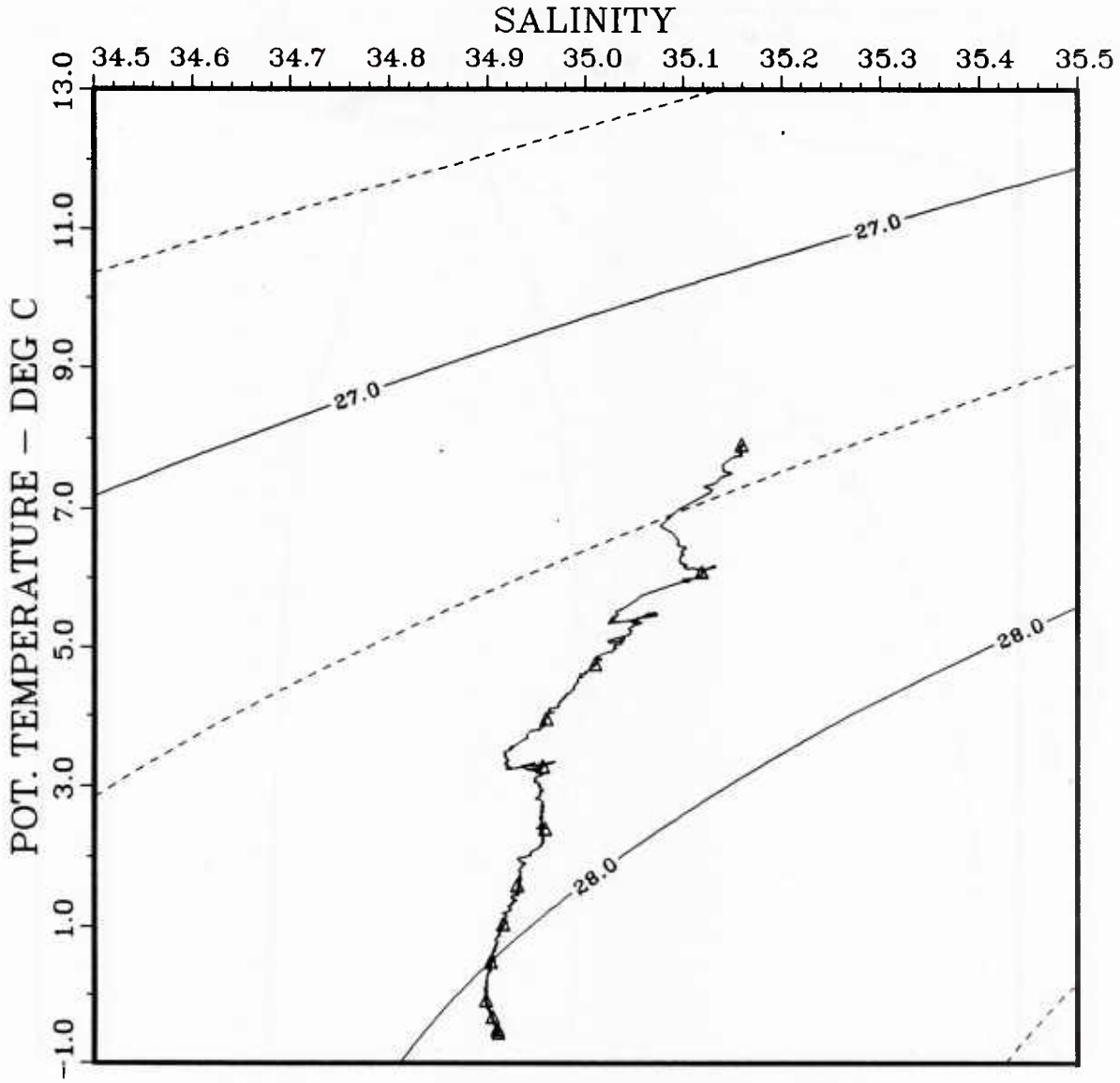
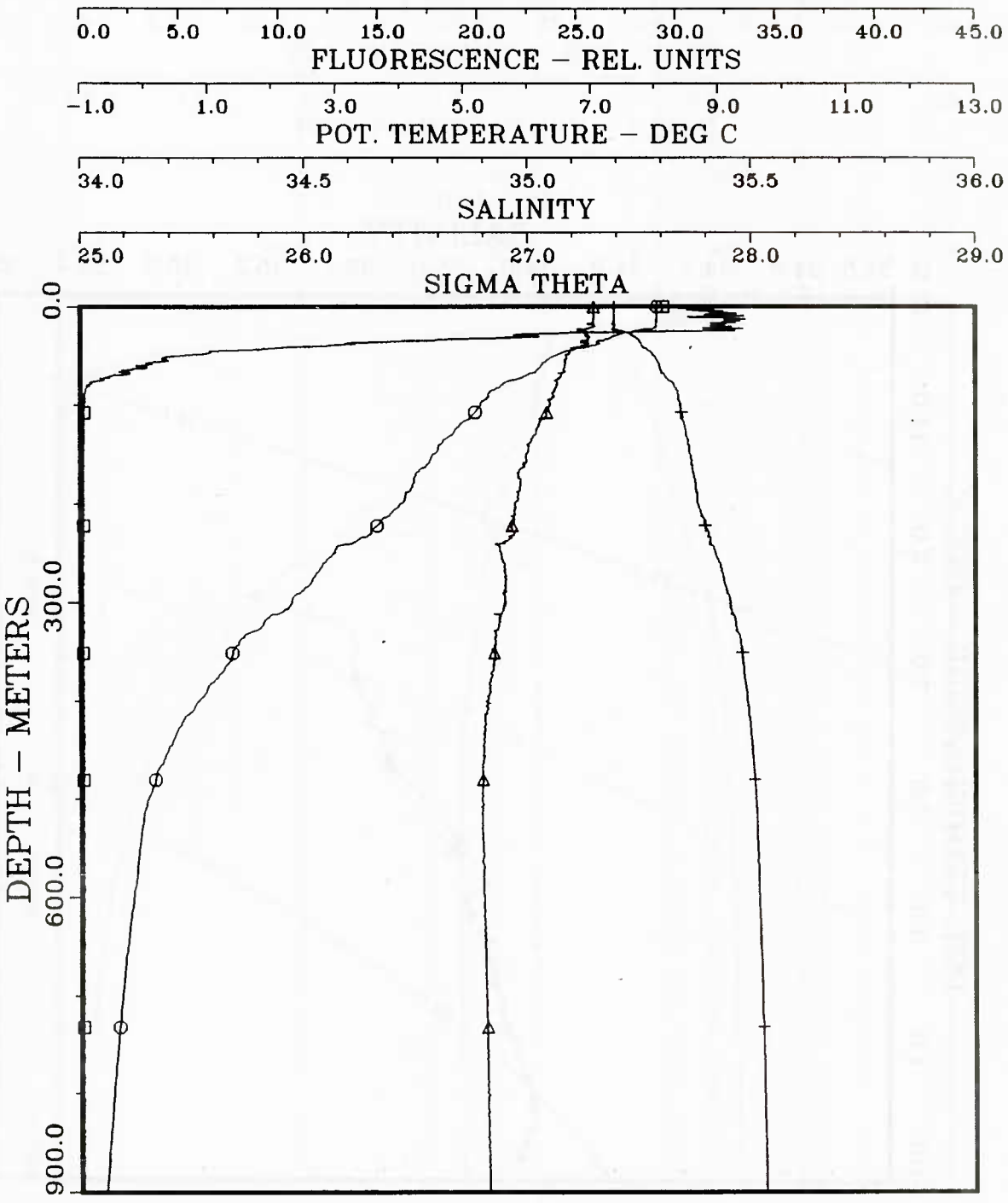



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 11 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 157.1730 | |
| LATITUDE | 65 33.19N | |
| LONGITUDE | 000 49.10W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

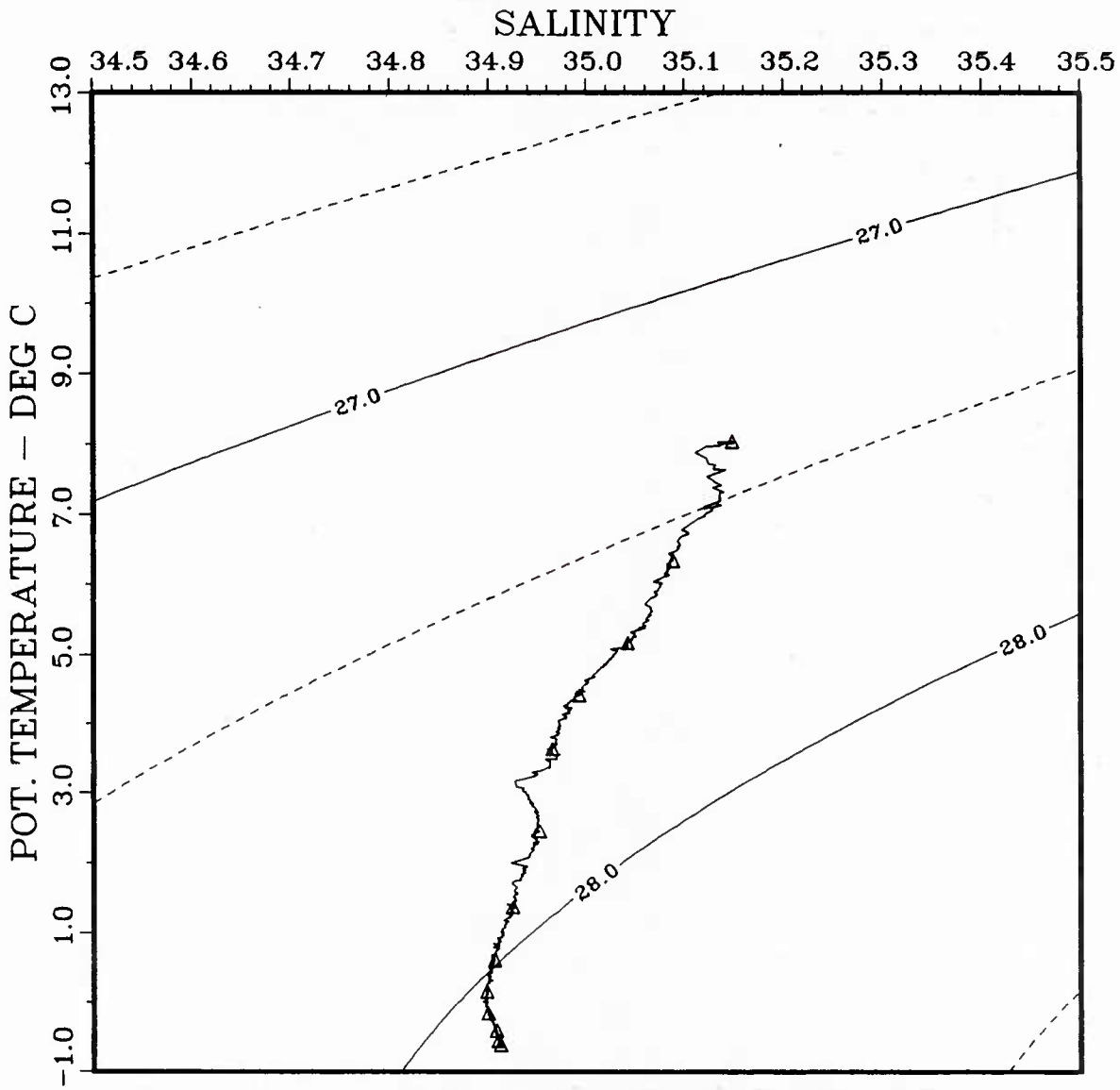



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 11 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 157.1730 | |
| LATITUDE | 65 33.19N | |
| LONGITUDE | 000 49.10W | |

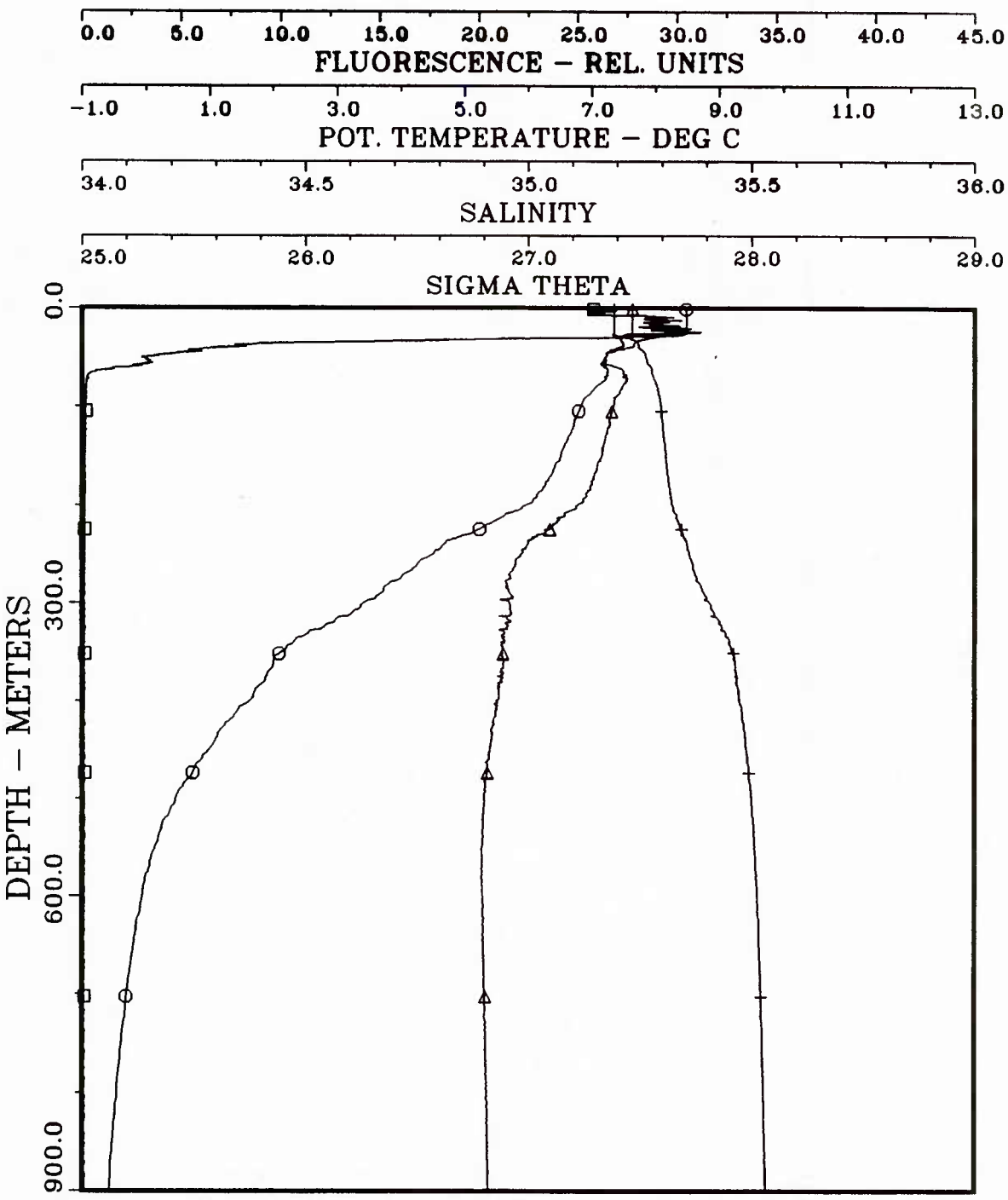



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 13 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0030 | |
| LATITUDE | 65 58.88N | |
| LONGITUDE | 000 39.87W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 13 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0030 | |
| LATITUDE | 65 58.88N | |
| LONGITUDE | 000 39.87W | |




| | | |
|---|---|---|
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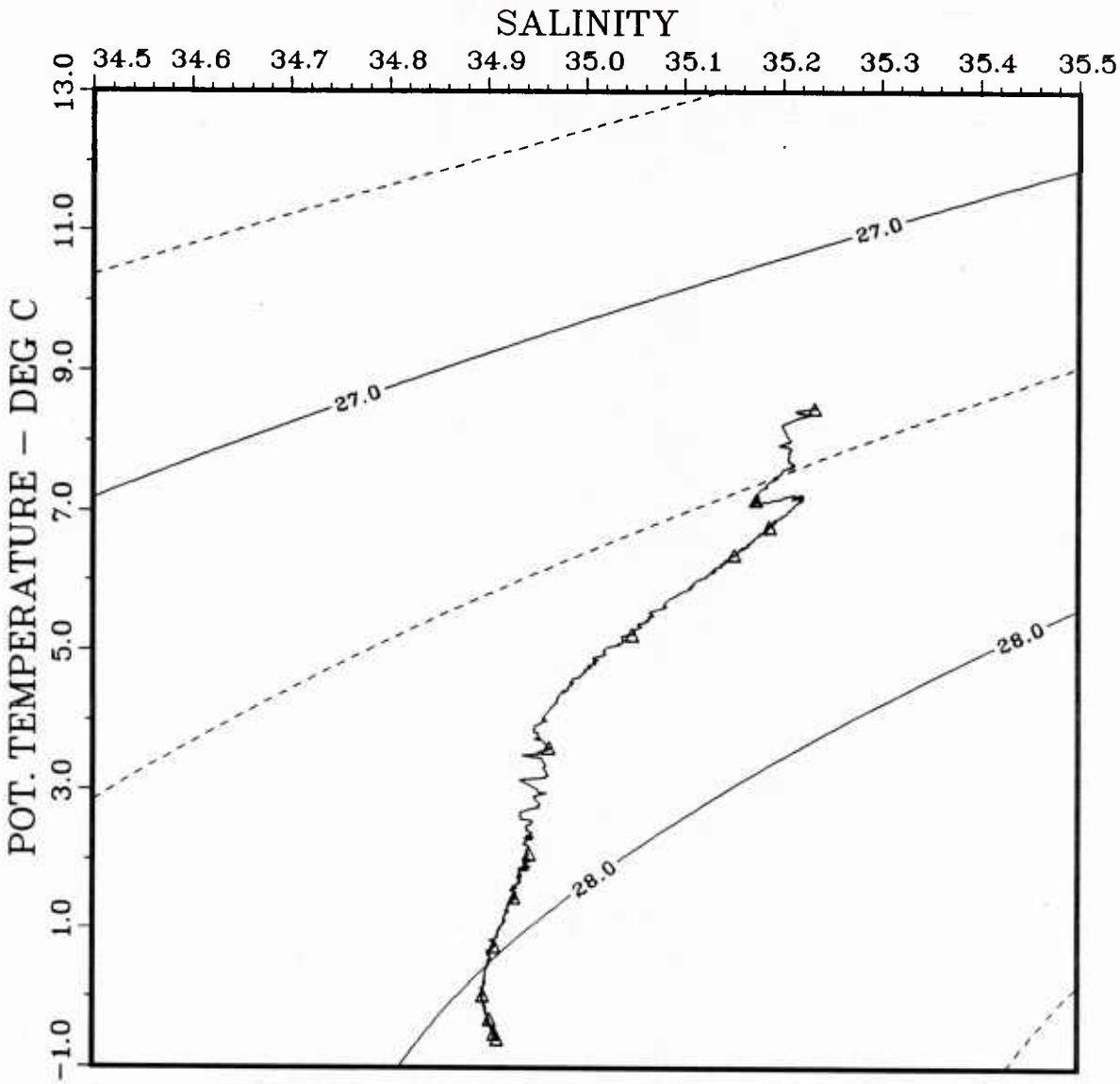
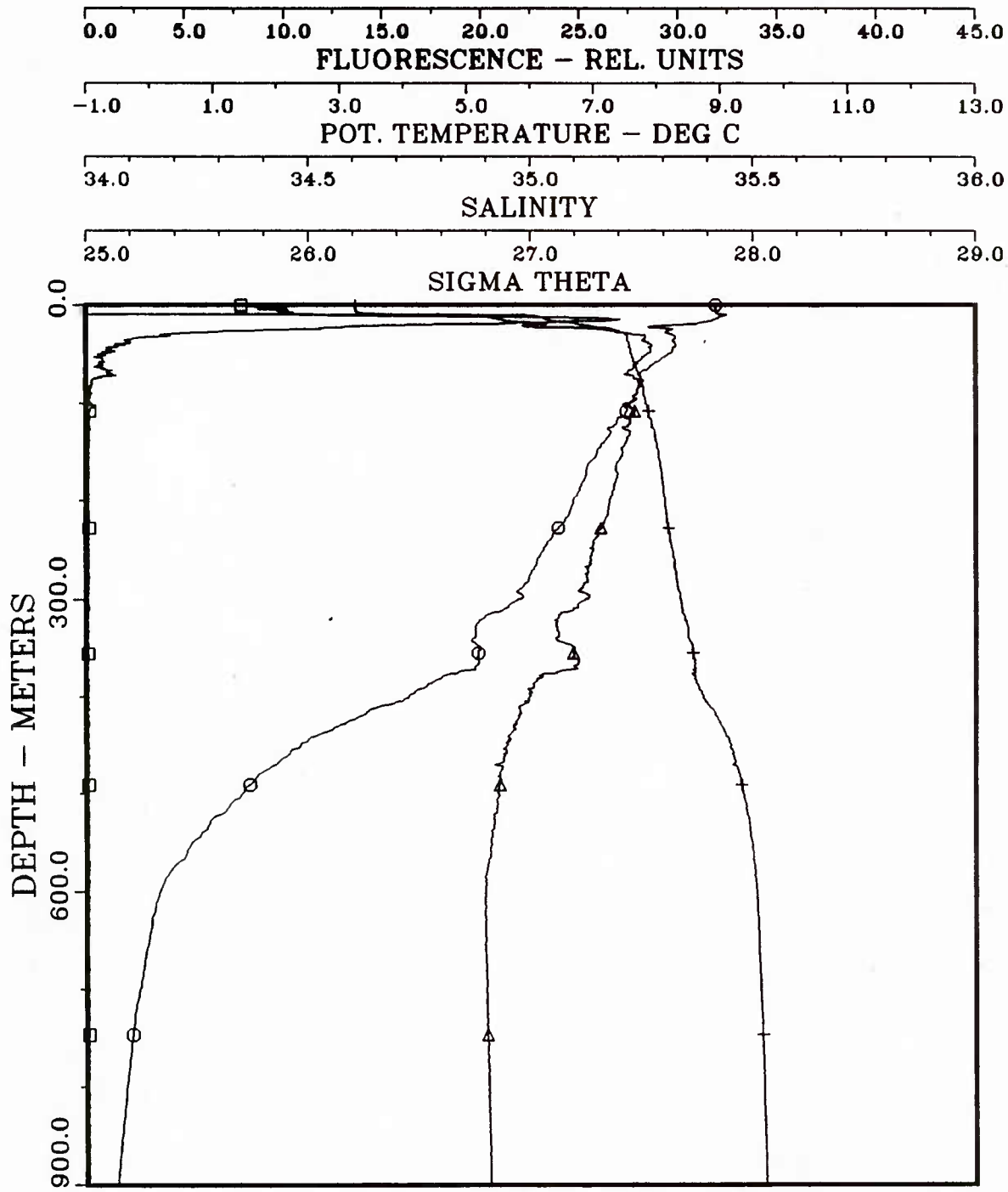
| STATION | 14 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0330 | |
| LATITUDE | 64 41.69N | |
| LONGITUDE | 001 23.28E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

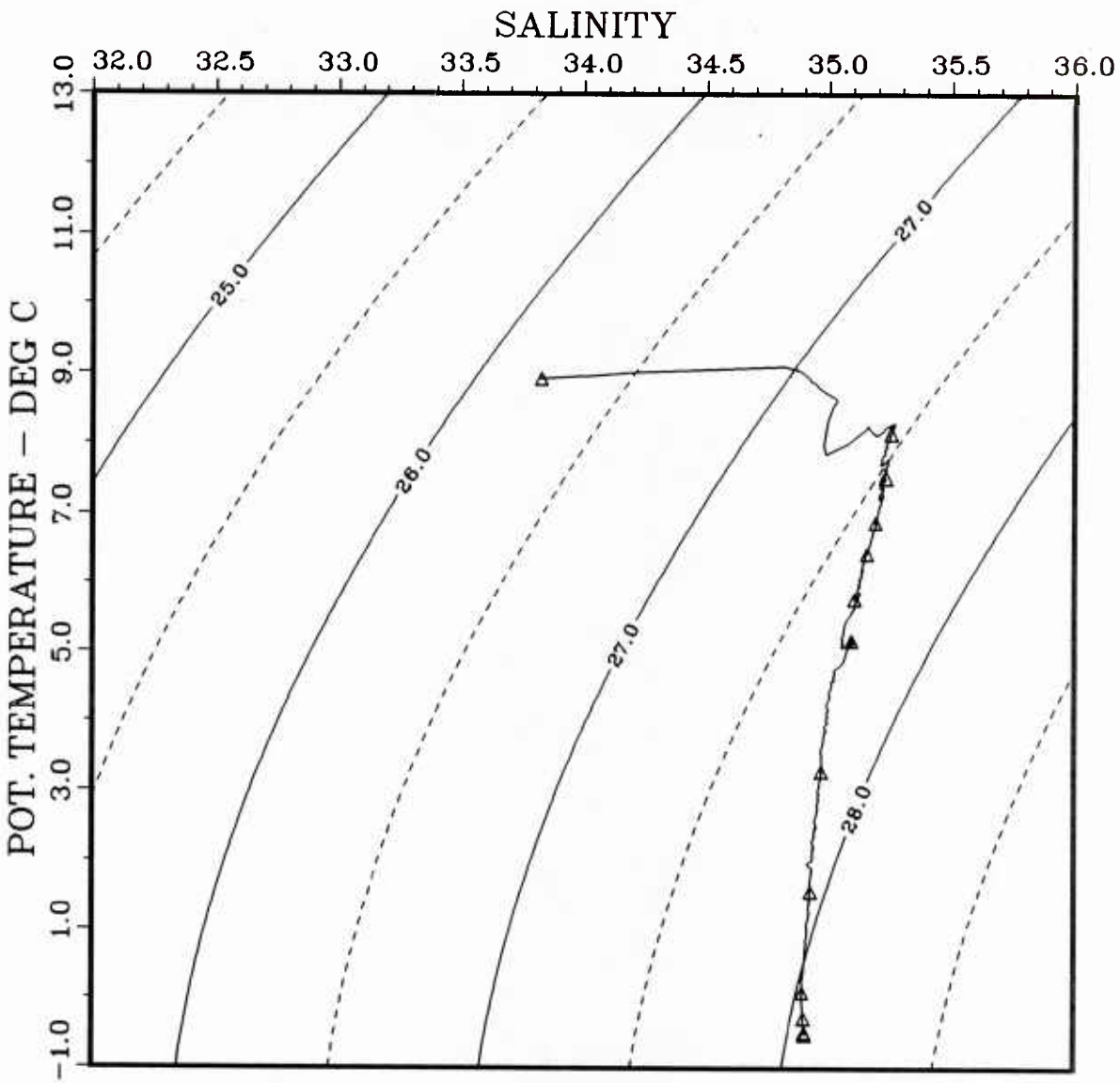



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 14 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0330 | |
| LATITUDE | 64 41.69N | |
| LONGITUDE | 001 23.28E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 15 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0630 | |
| LATITUDE | 64 24.92N | |
| LONGITUDE | 002 07.35E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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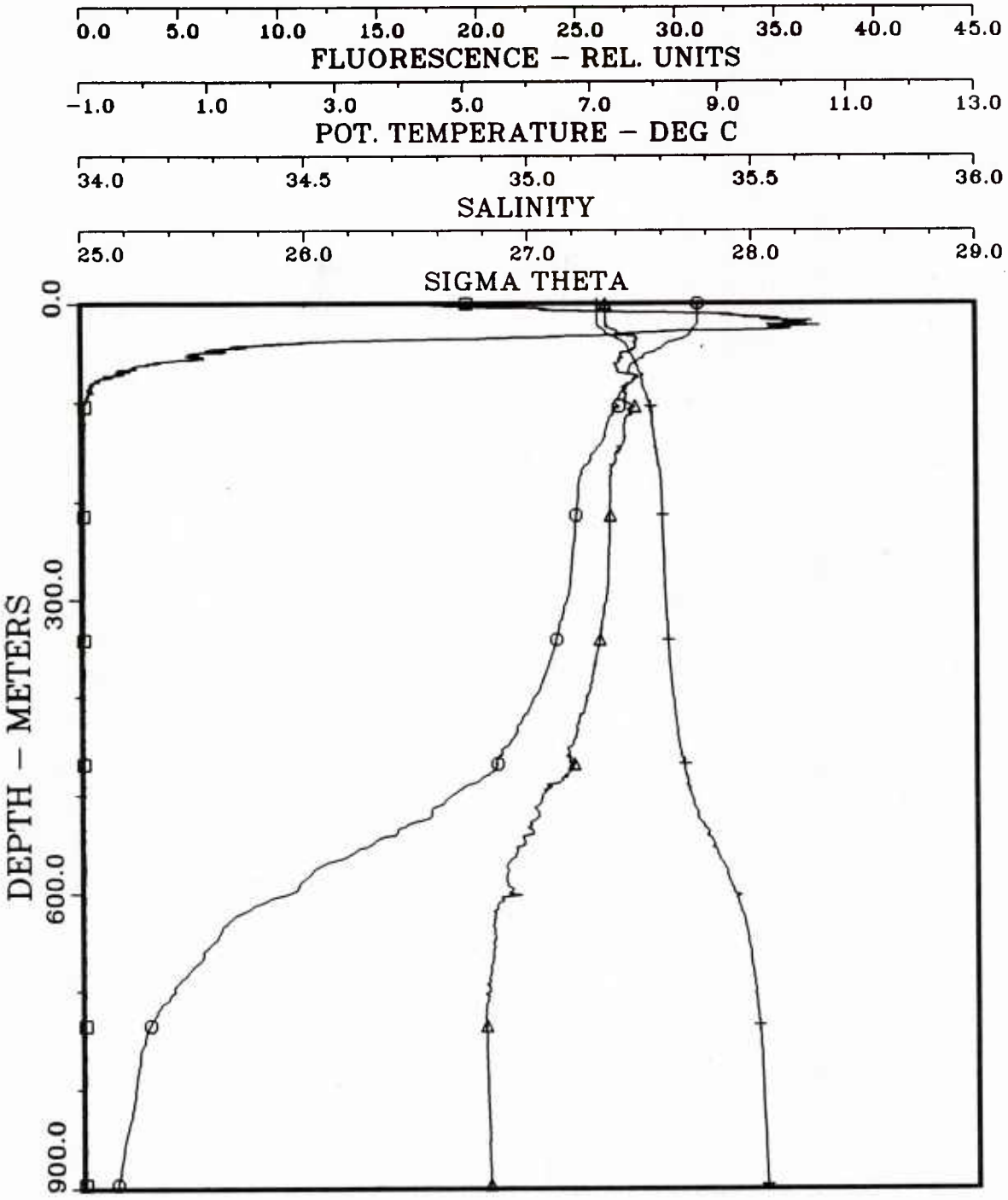
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 15 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0630 | |
| LATITUDE | 64 24.92N | |
| LONGITUDE | 002 07.35E | |

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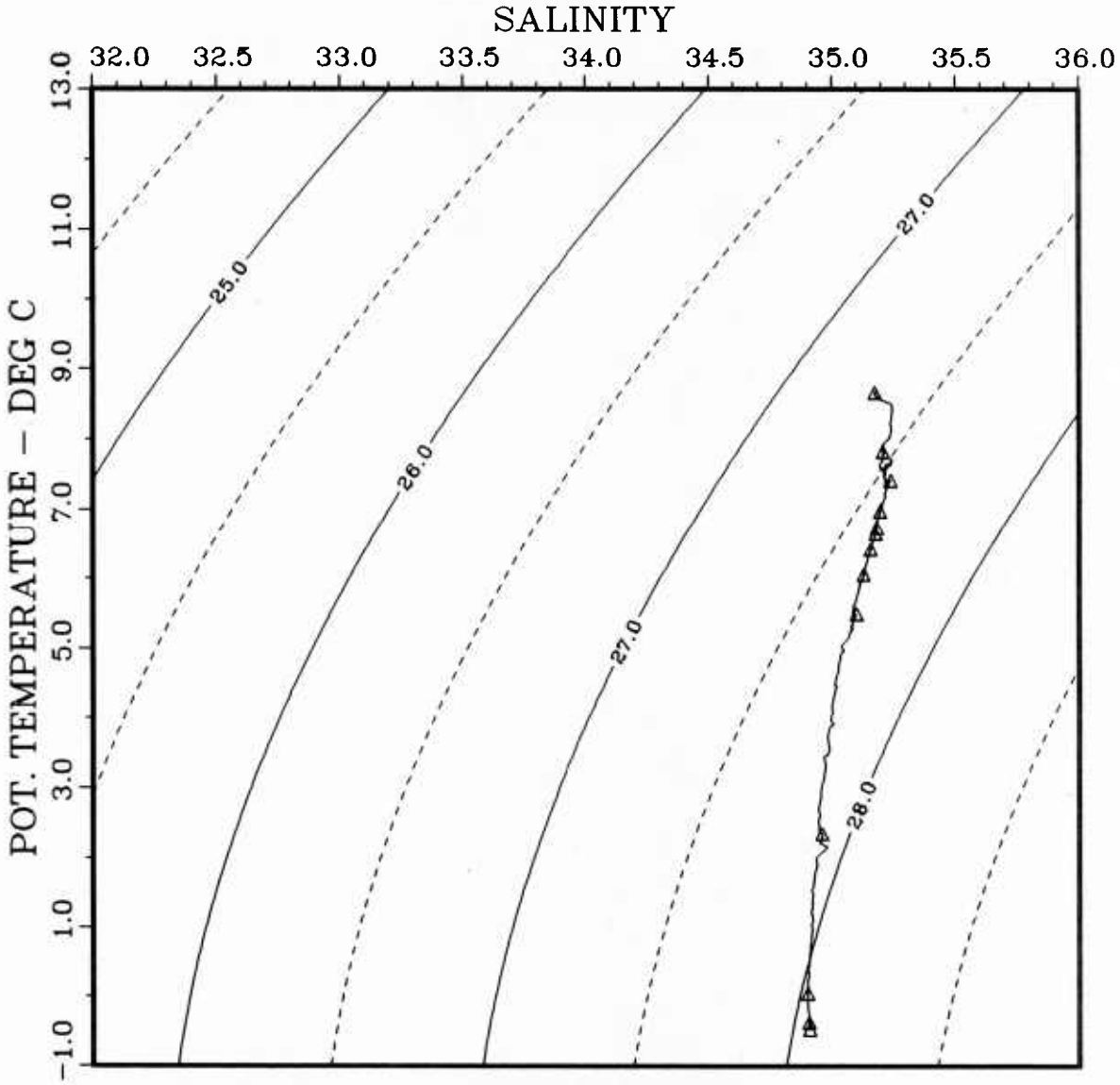
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 16 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0940 | |
| LATITUDE | 64 07.32N | |
| LONGITUDE | 002 52.03E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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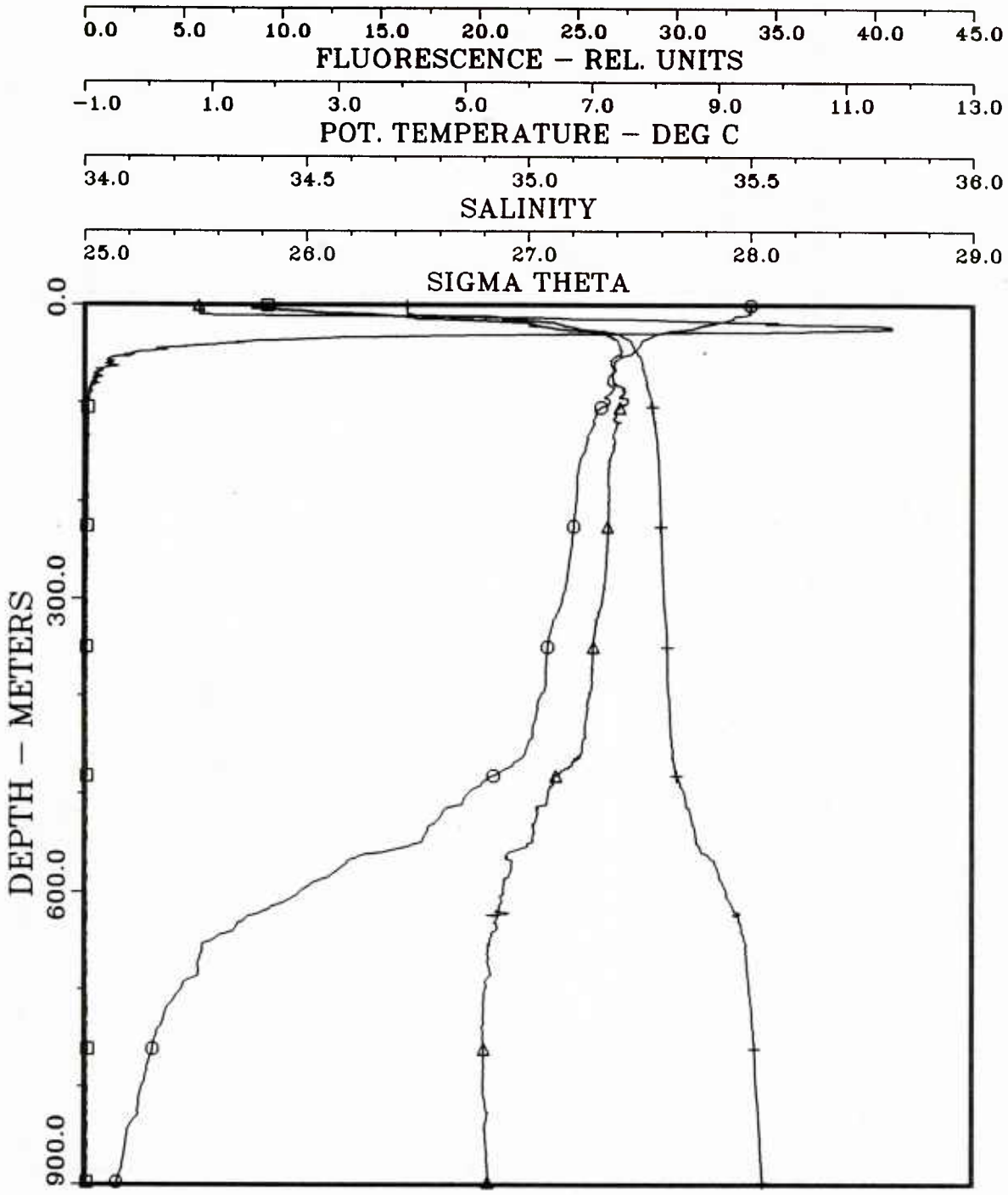
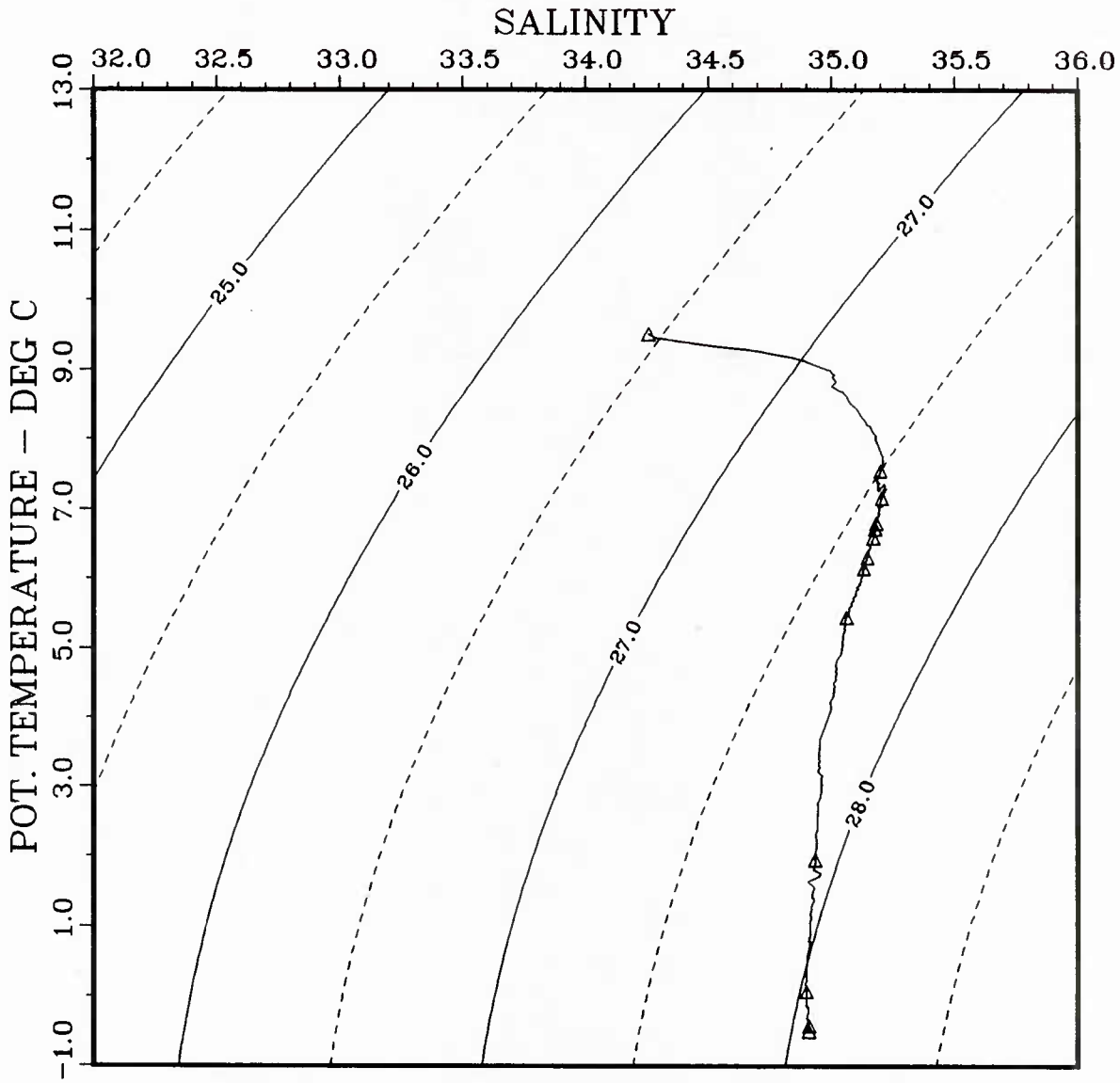
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 16 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.0940 | |
| LATITUDE | 64 07.32N | |
| LONGITUDE | 002 52.03E | |

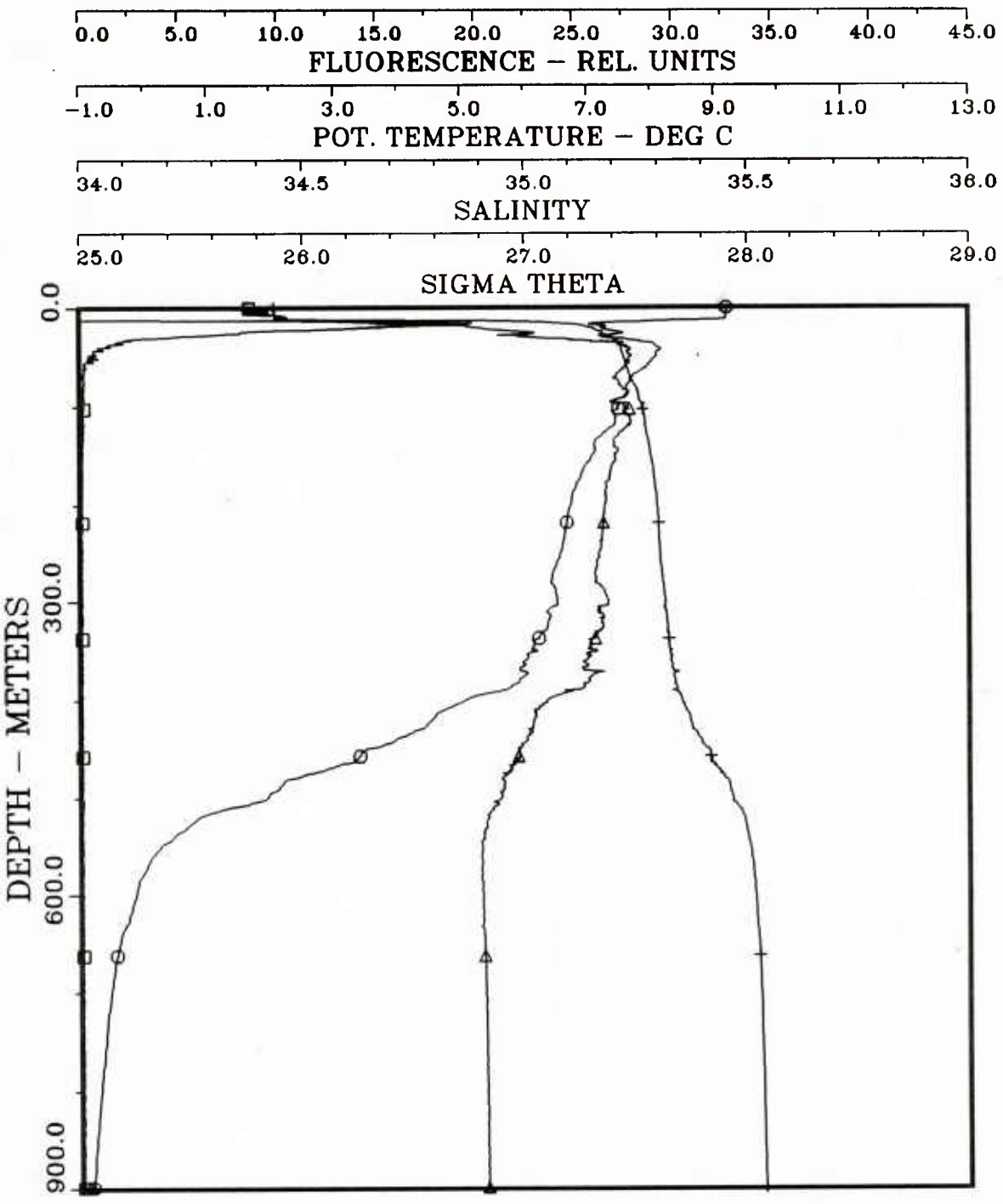



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 17 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.1320 | |
| LATITUDE | 63 47.73N | |
| LONGITUDE | 003 36.16E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

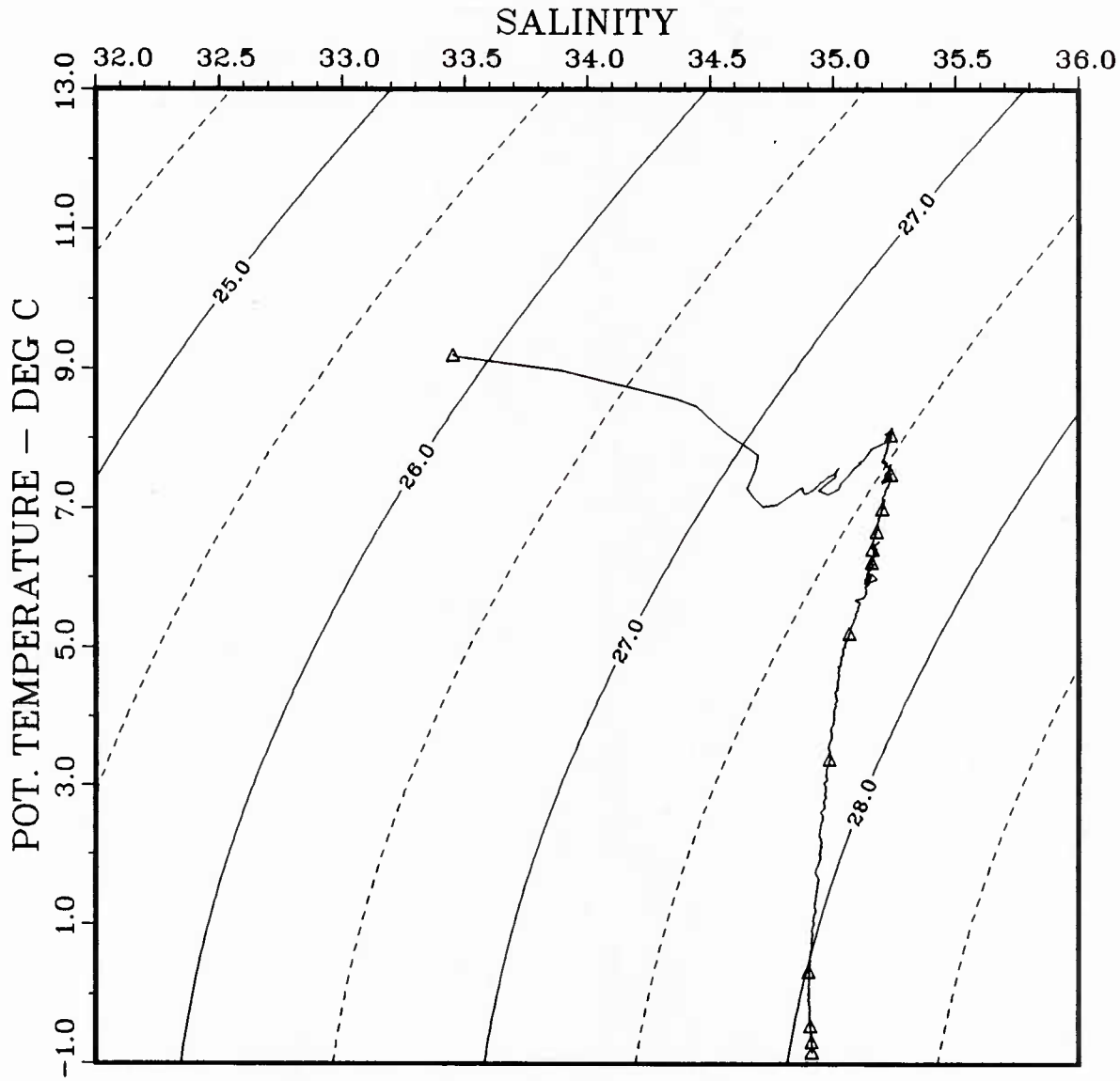



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 17 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.1320 | |
| LATITUDE | 63 47.73N | |
| LONGITUDE | 003 36.16E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 18 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.1640 | |
| LATITUDE | 63 25.73N | |
| LONGITUDE | 004 25.45E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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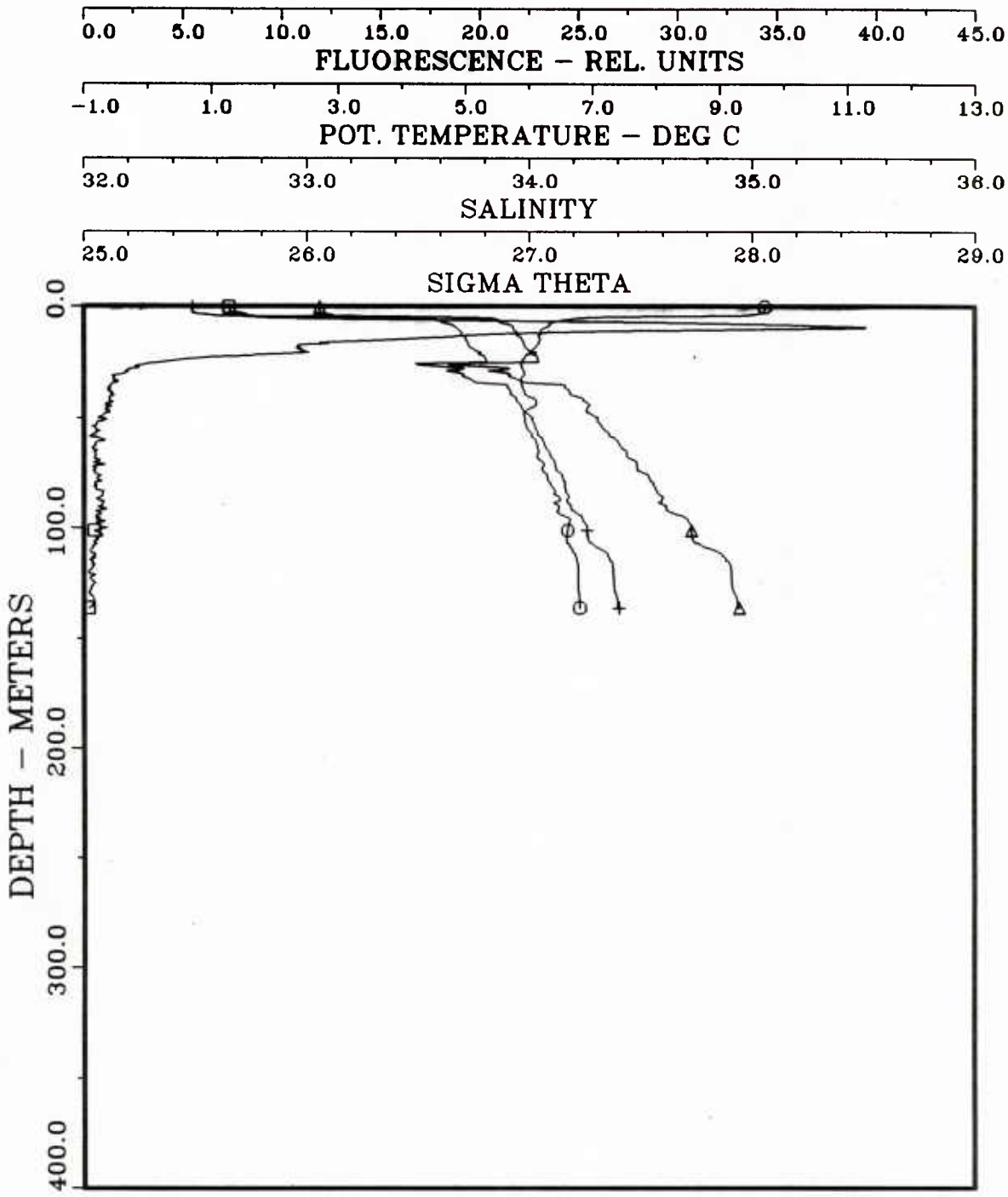
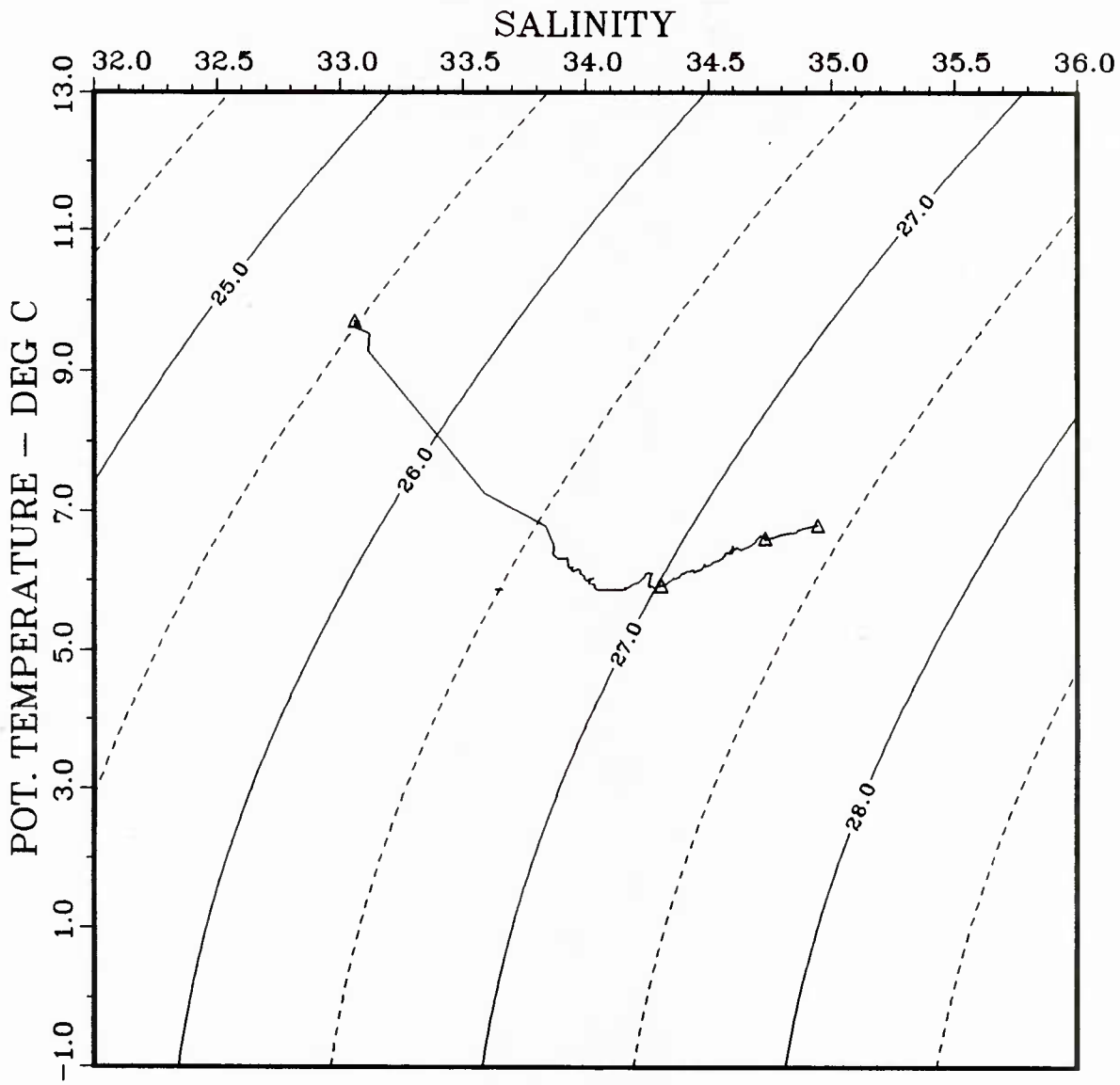
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 18 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 158.1640 | |
| LATITUDE | 63 25.73N | |
| LONGITUDE | 004 25.45E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 19 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 160.2150 | |
| LATITUDE | 65 15.79N | |
| LONGITUDE | 010 14.82E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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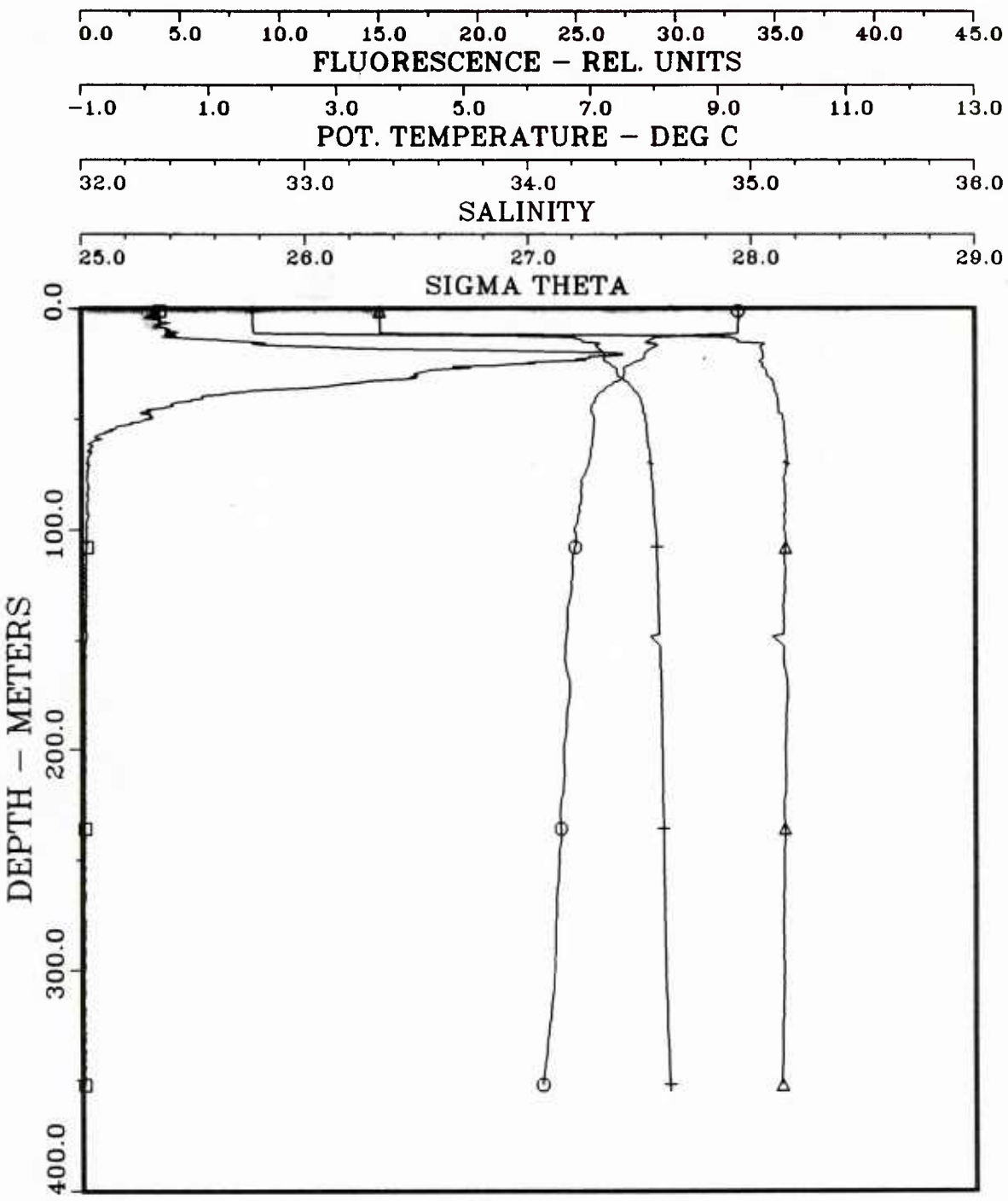
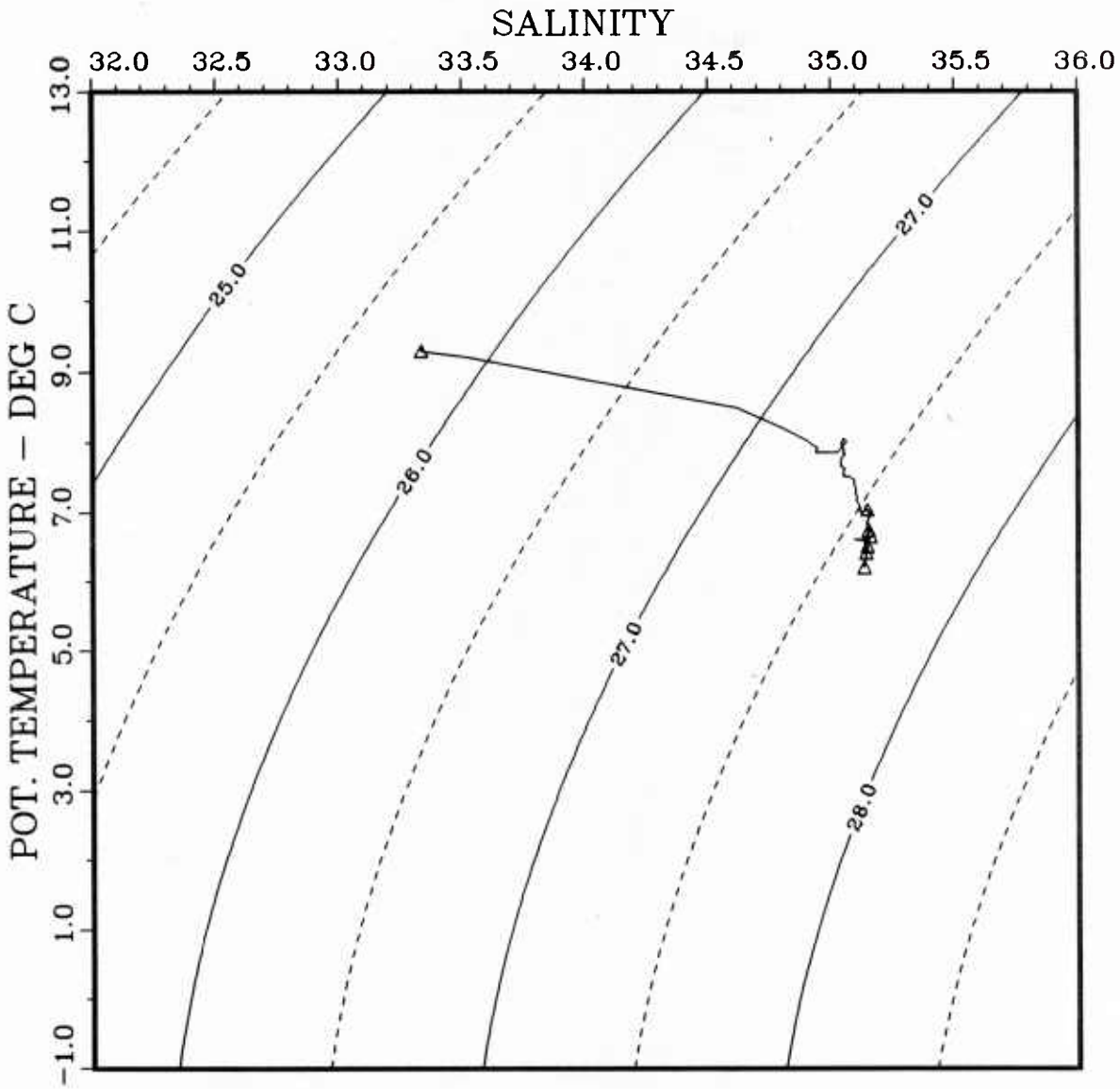
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 19 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 160.2150 | |
| LATITUDE | 65 15.79N | |
| LONGITUDE | 010 14.82E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 20 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0030 | |
| LATITUDE | 65 31.95N | |
| LONGITUDE | 009 31.29E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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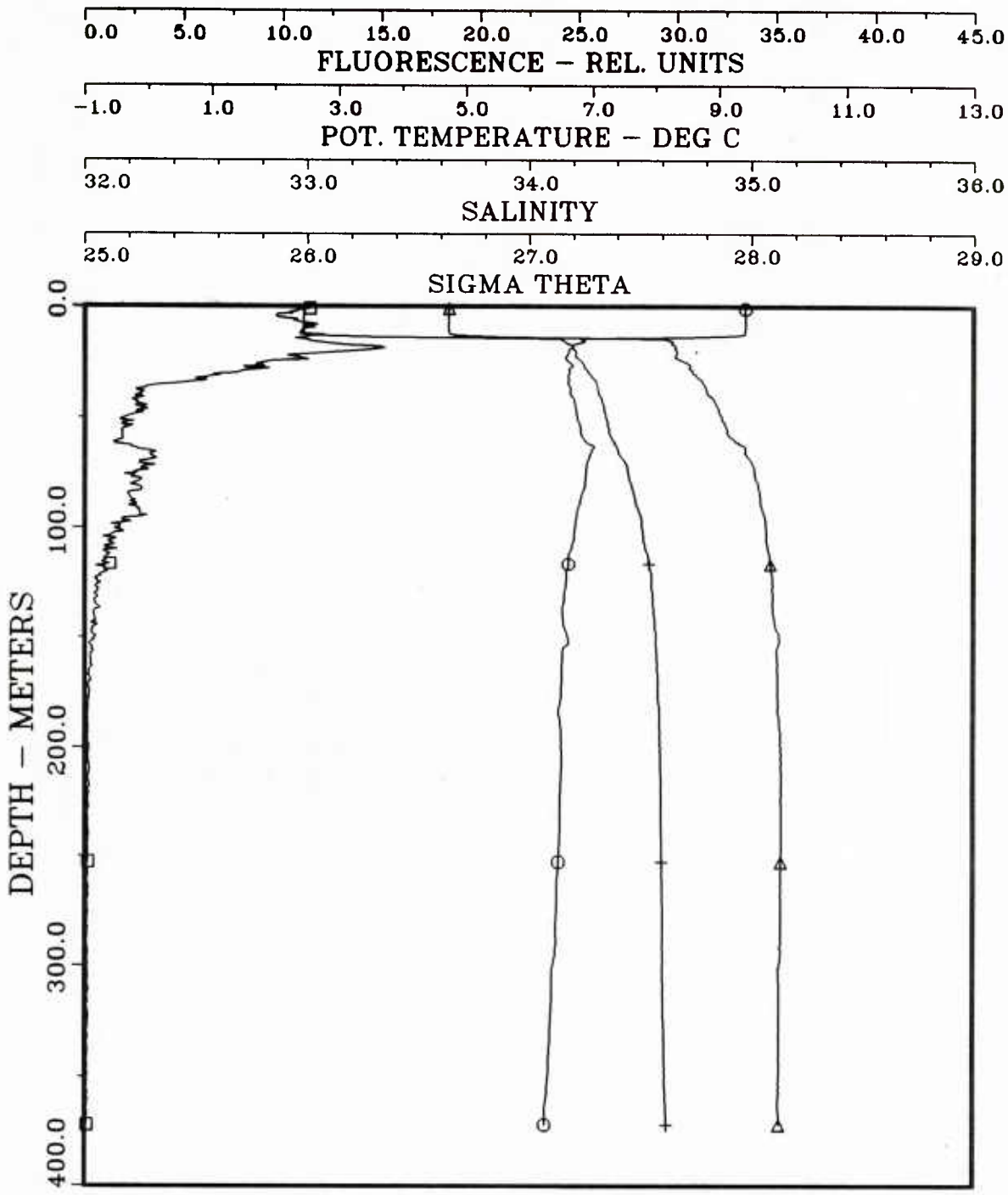
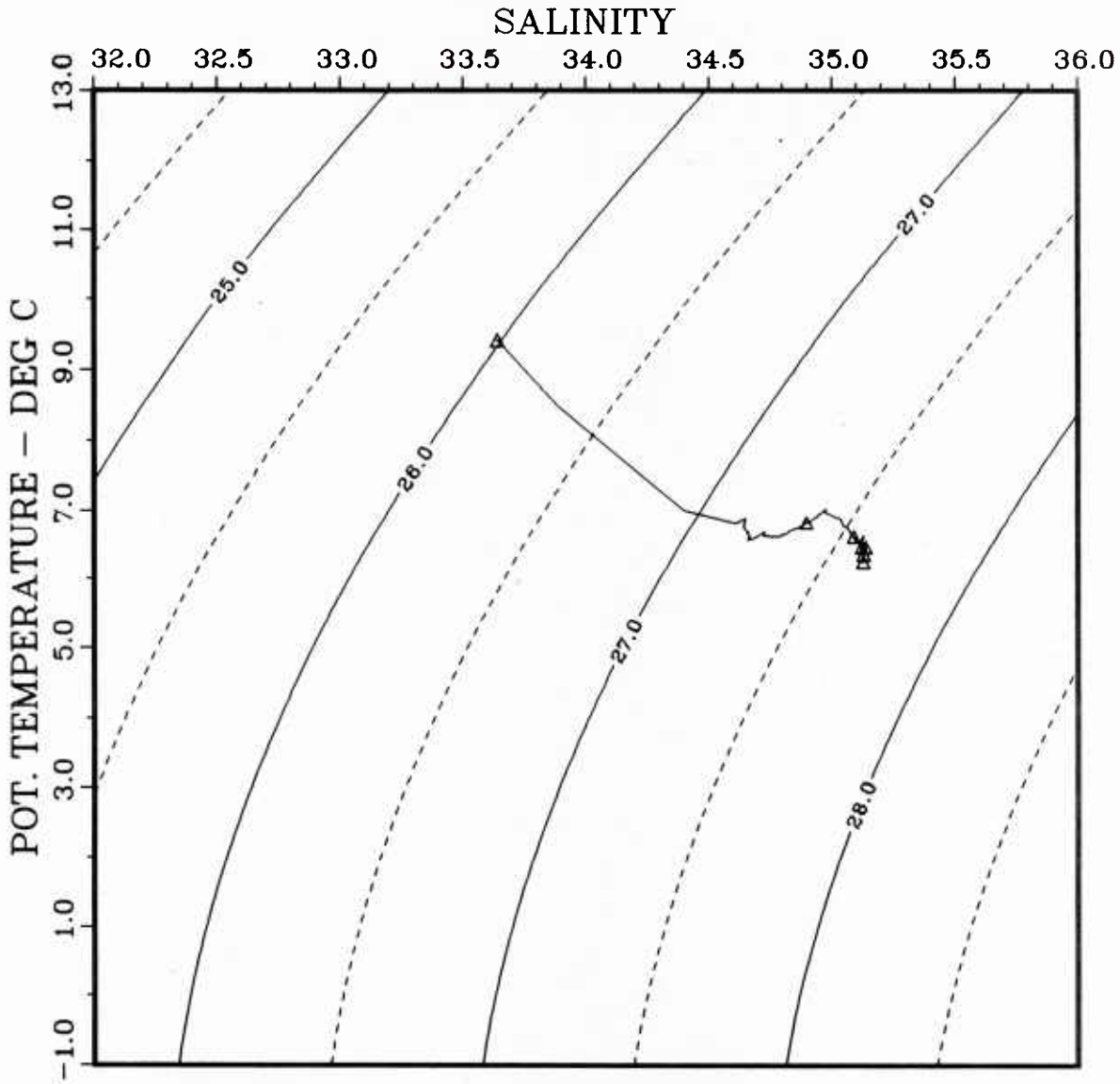
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 20 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0030 | |
| LATITUDE | 65 31.95N | |
| LONGITUDE | 009 31.29E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 21 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0330 | |
| LATITUDE | 65 48.20N | |
| LONGITUDE | 008 46.04E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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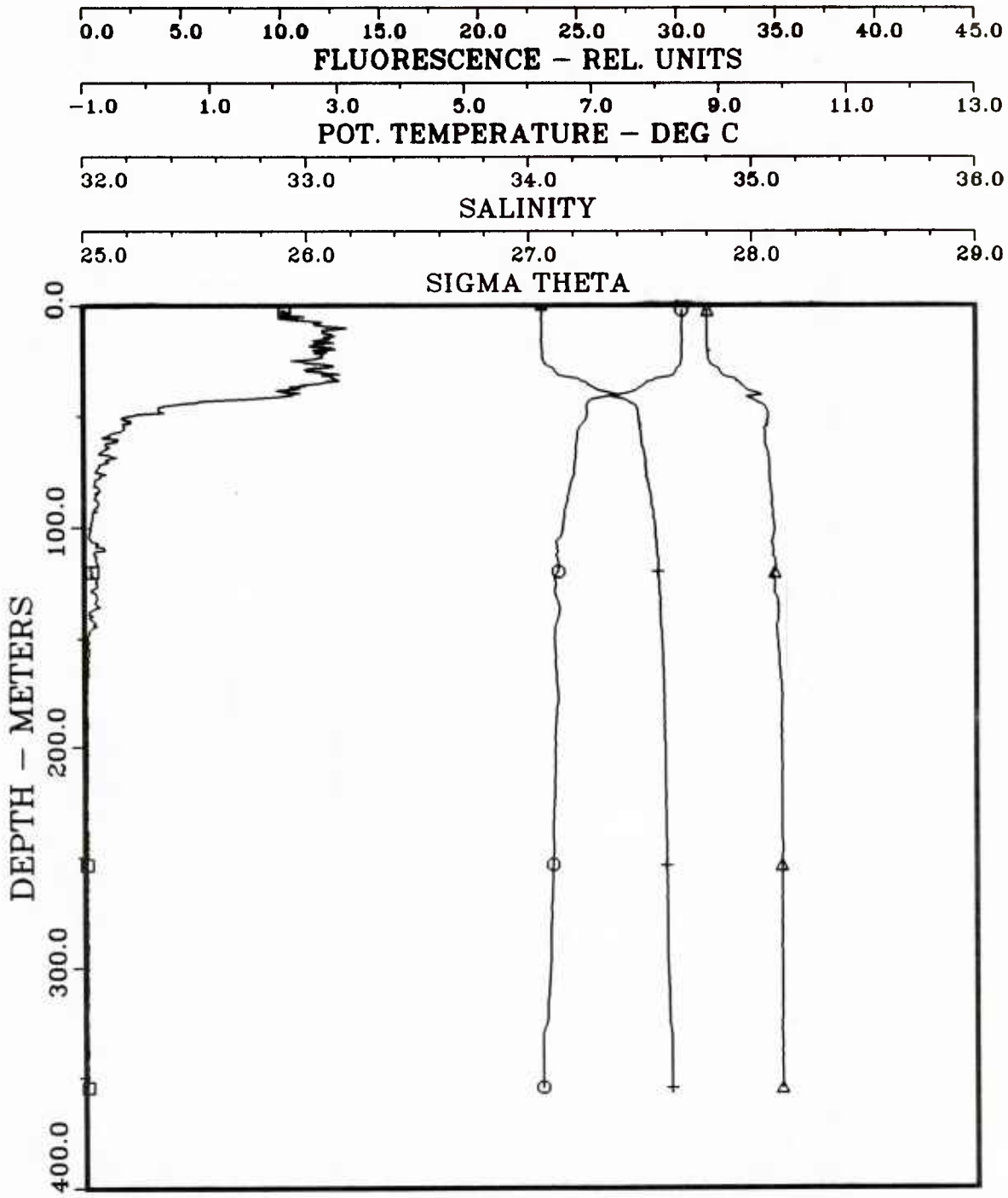
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 21 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0330 | |
| LATITUDE | 65 48.20N | |
| LONGITUDE | 008 46.04E | |

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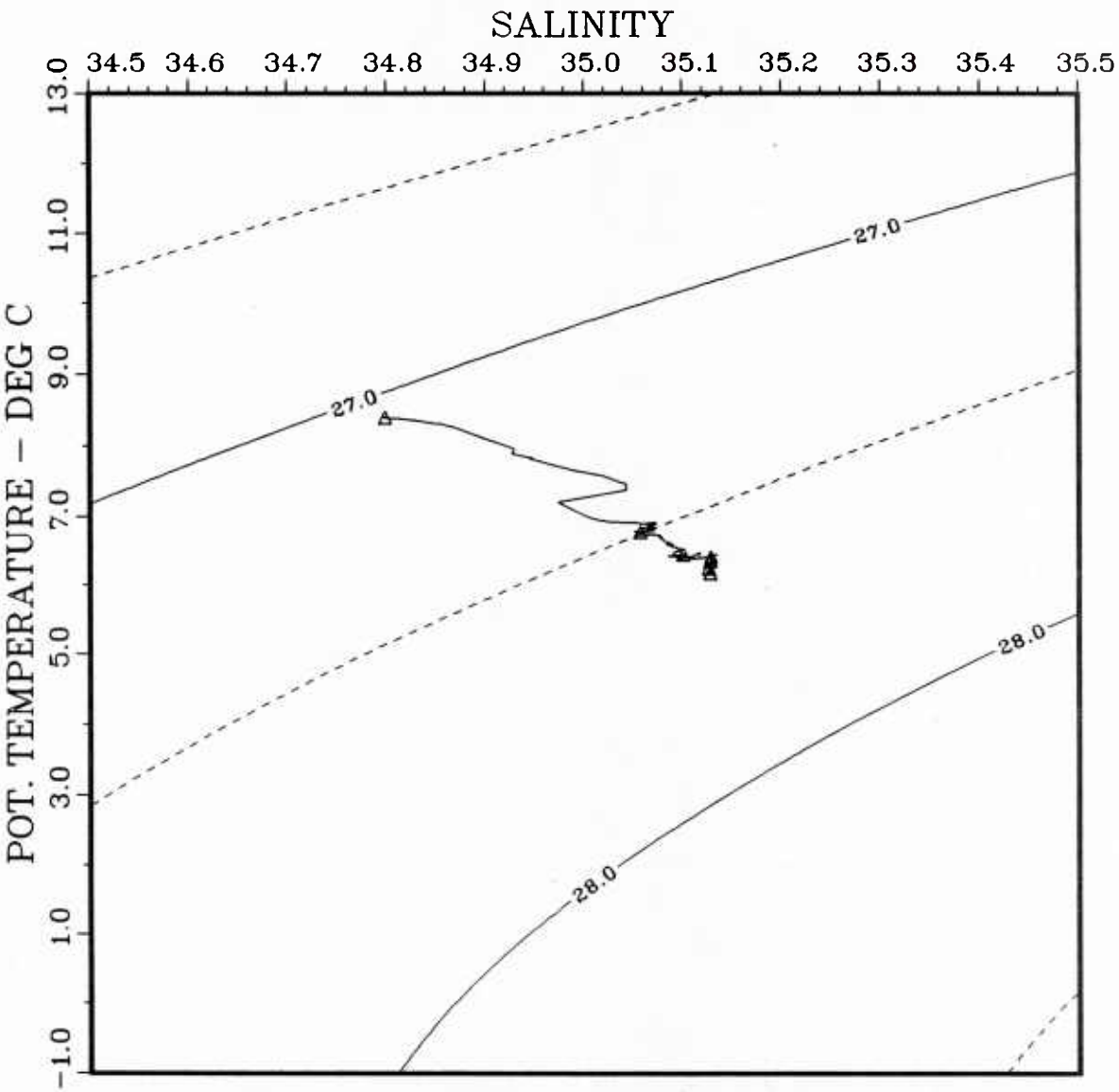
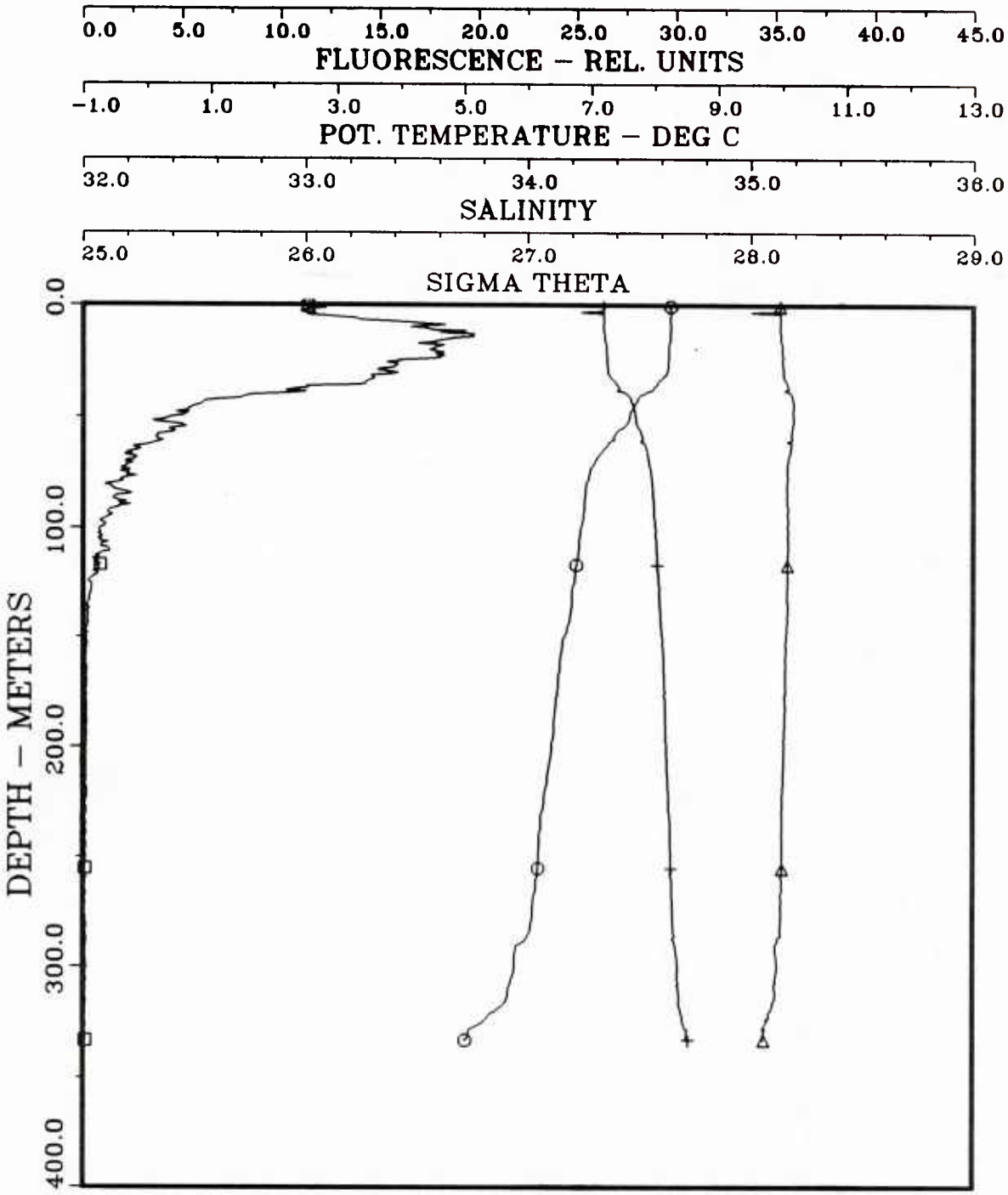
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 22 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0700 | |
| LATITUDE | 66 03.13N | |
| LONGITUDE | 008 03.29E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 22 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0700 | |
| LATITUDE | 66 03.13N | |
| LONGITUDE | 008 03.29E | |

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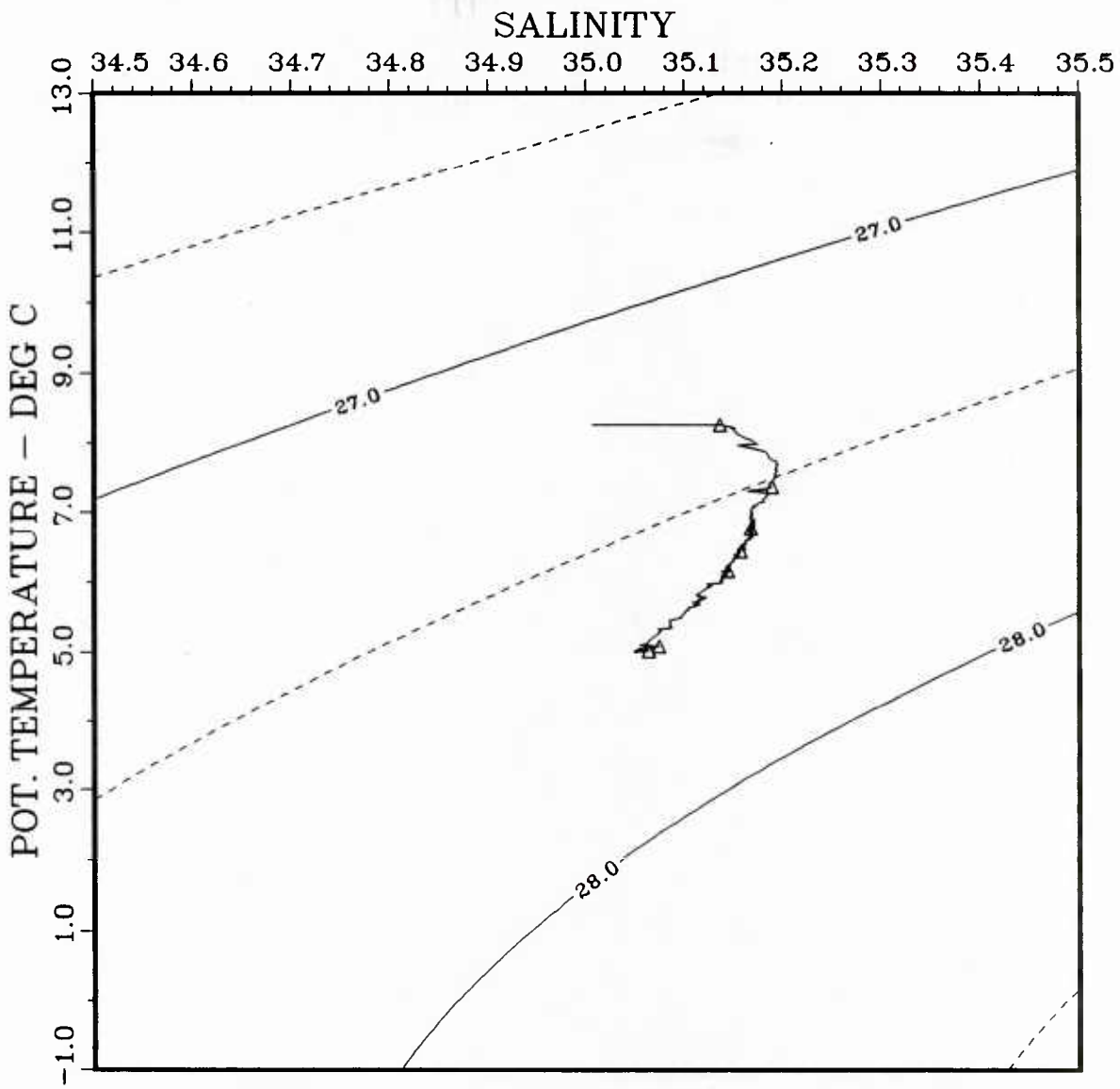
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 23 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0950 | |
| LATITUDE | 66 17.71N | |
| LONGITUDE | 007 18.60E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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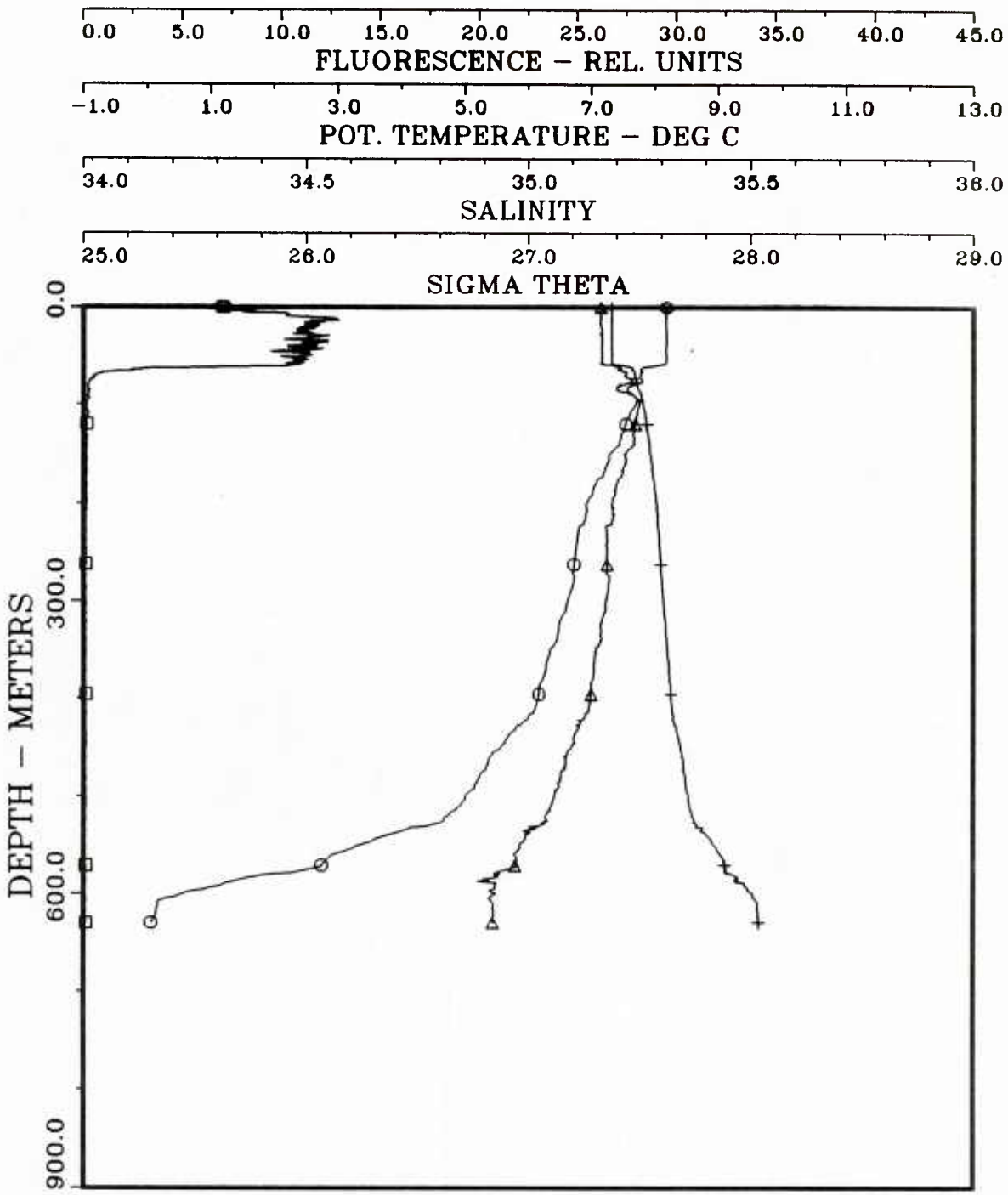
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 23 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.0950 | |
| LATITUDE | 66 17.71N | |
| LONGITUDE | 007 18.60E | |

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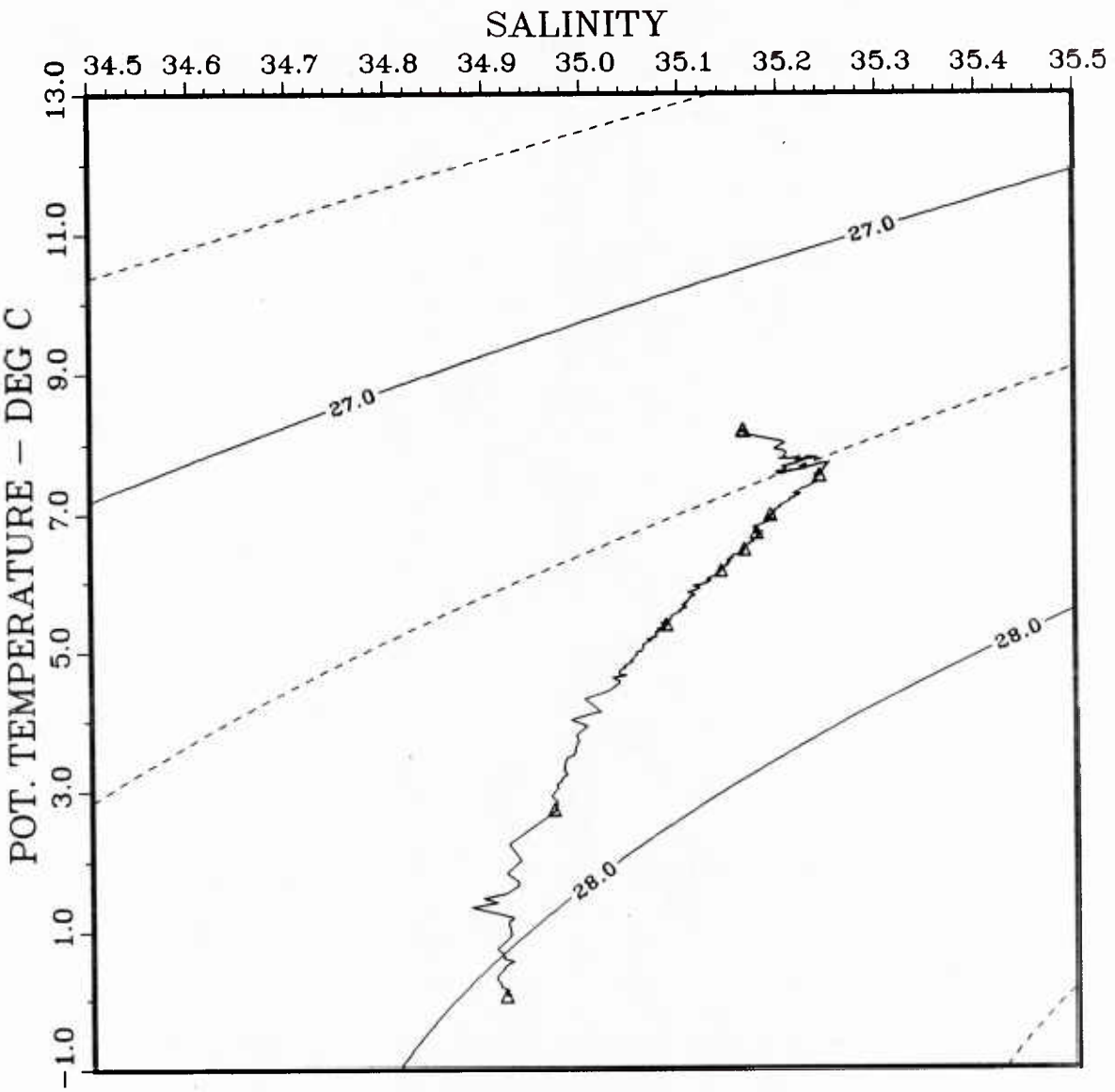
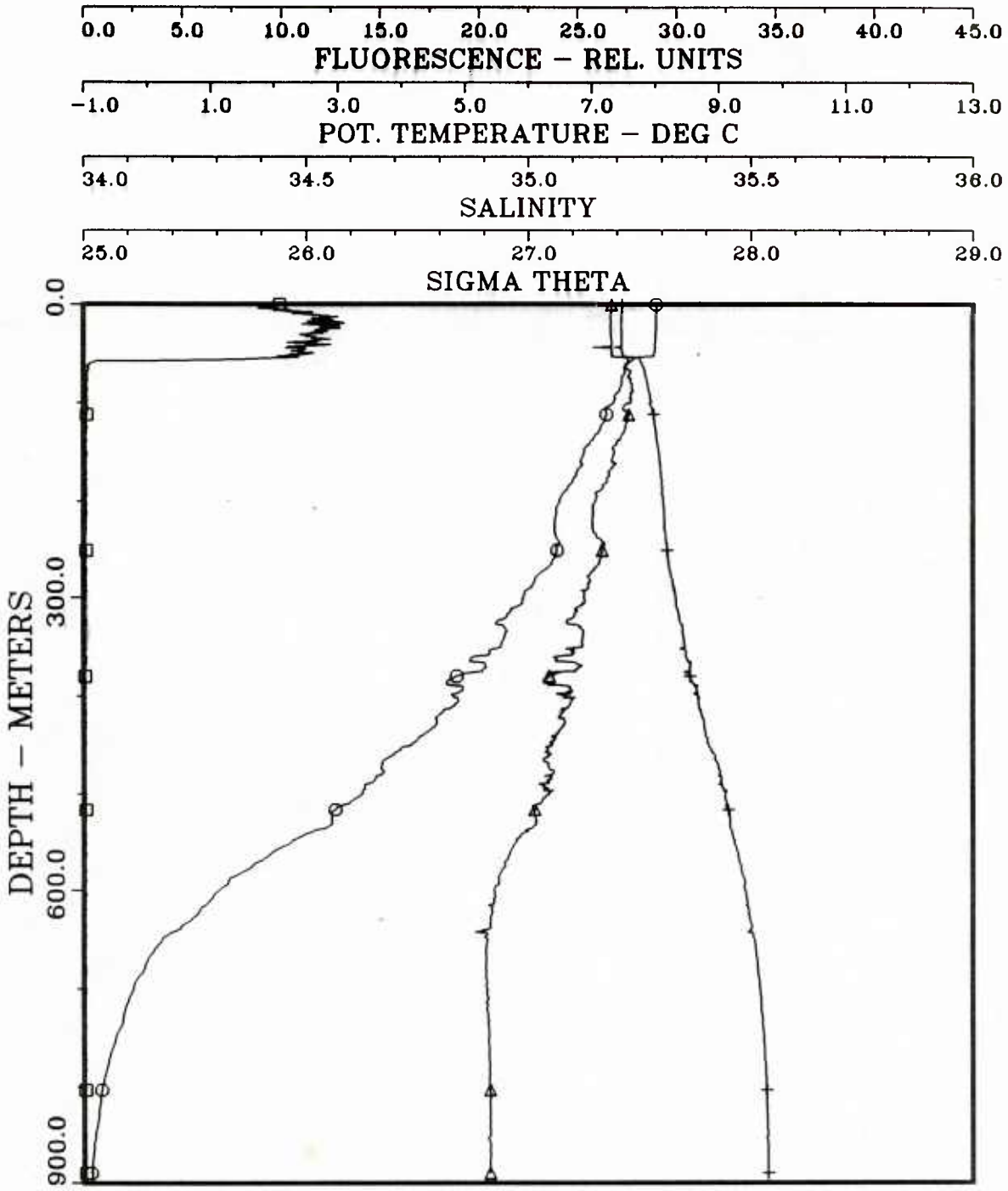
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 24 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.1240 | |
| LATITUDE | 66 31.34N | |
| LONGITUDE | 006 31.31E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 24 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.1240 | |
| LATITUDE | 66 31.34N | |
| LONGITUDE | 006 31.31E | |

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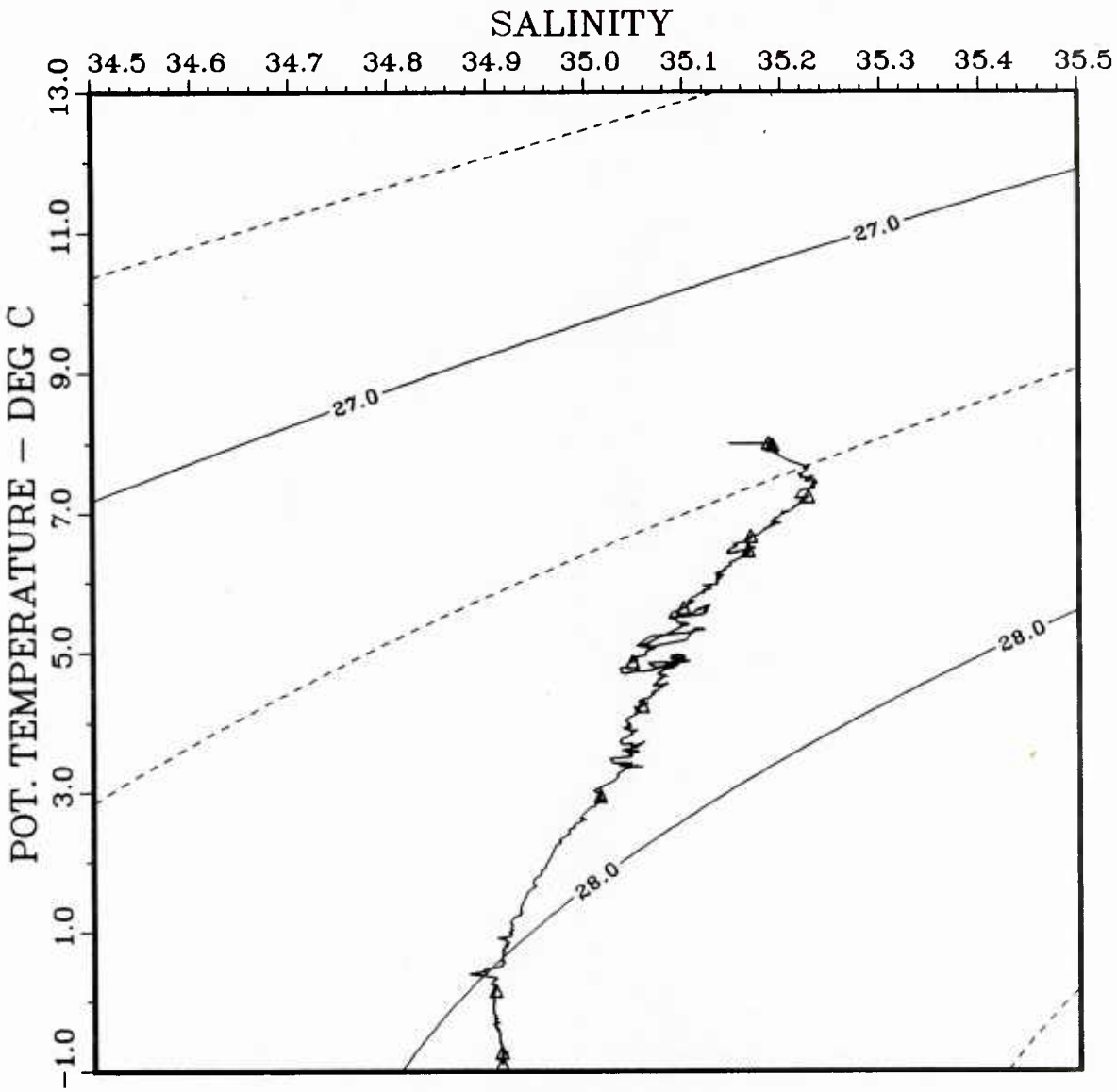
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 25 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.1520 | |
| LATITUDE | 66 44.96N | |
| LONGITUDE | 005 50.32E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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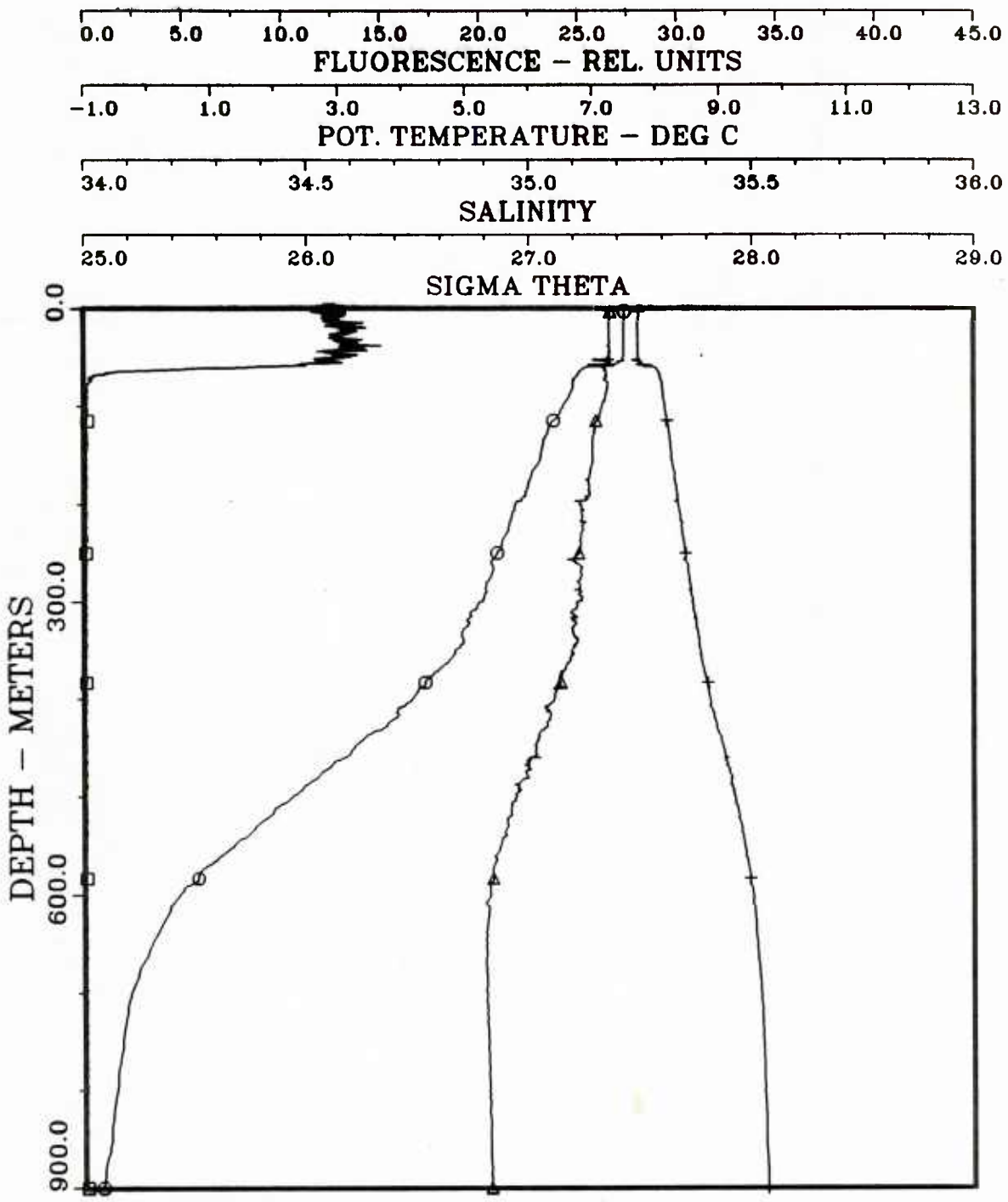
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 25 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.1520 | |
| LATITUDE | 66 44.96N | |
| LONGITUDE | 005 50.32E | |

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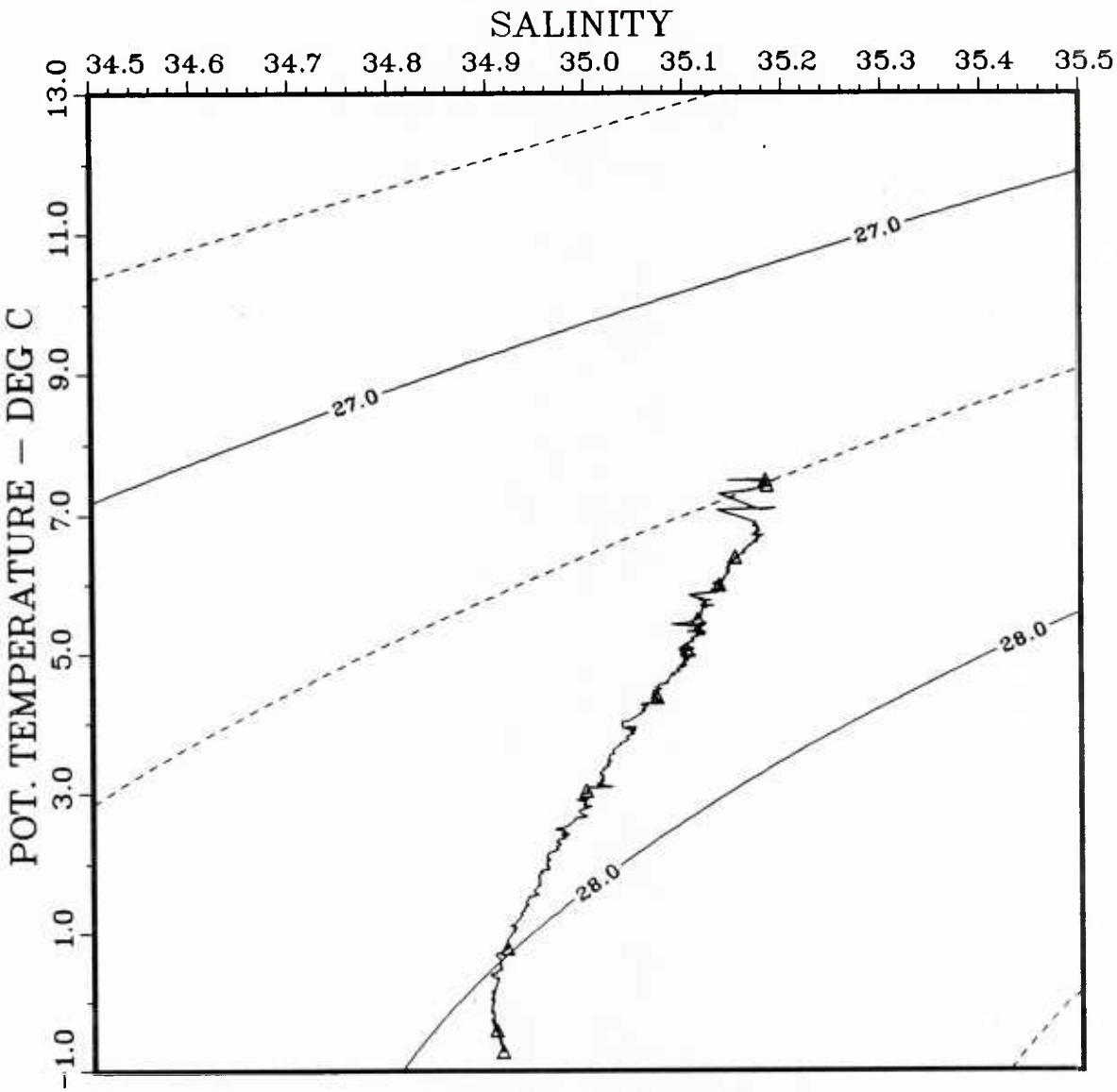
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 26 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.1820 | |
| LATITUDE | 66 58.08N | |
| LONGITUDE | 005 04.36E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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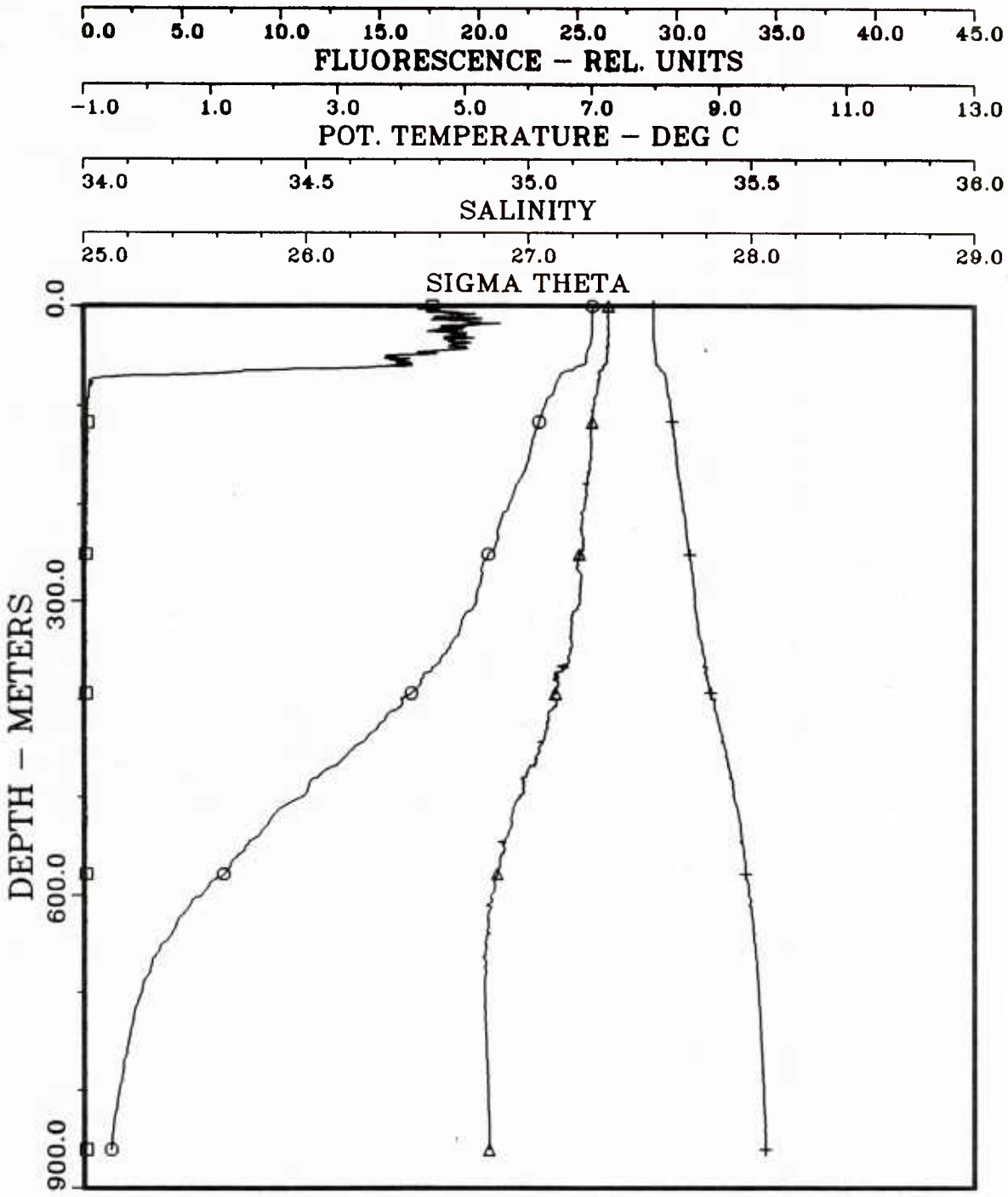
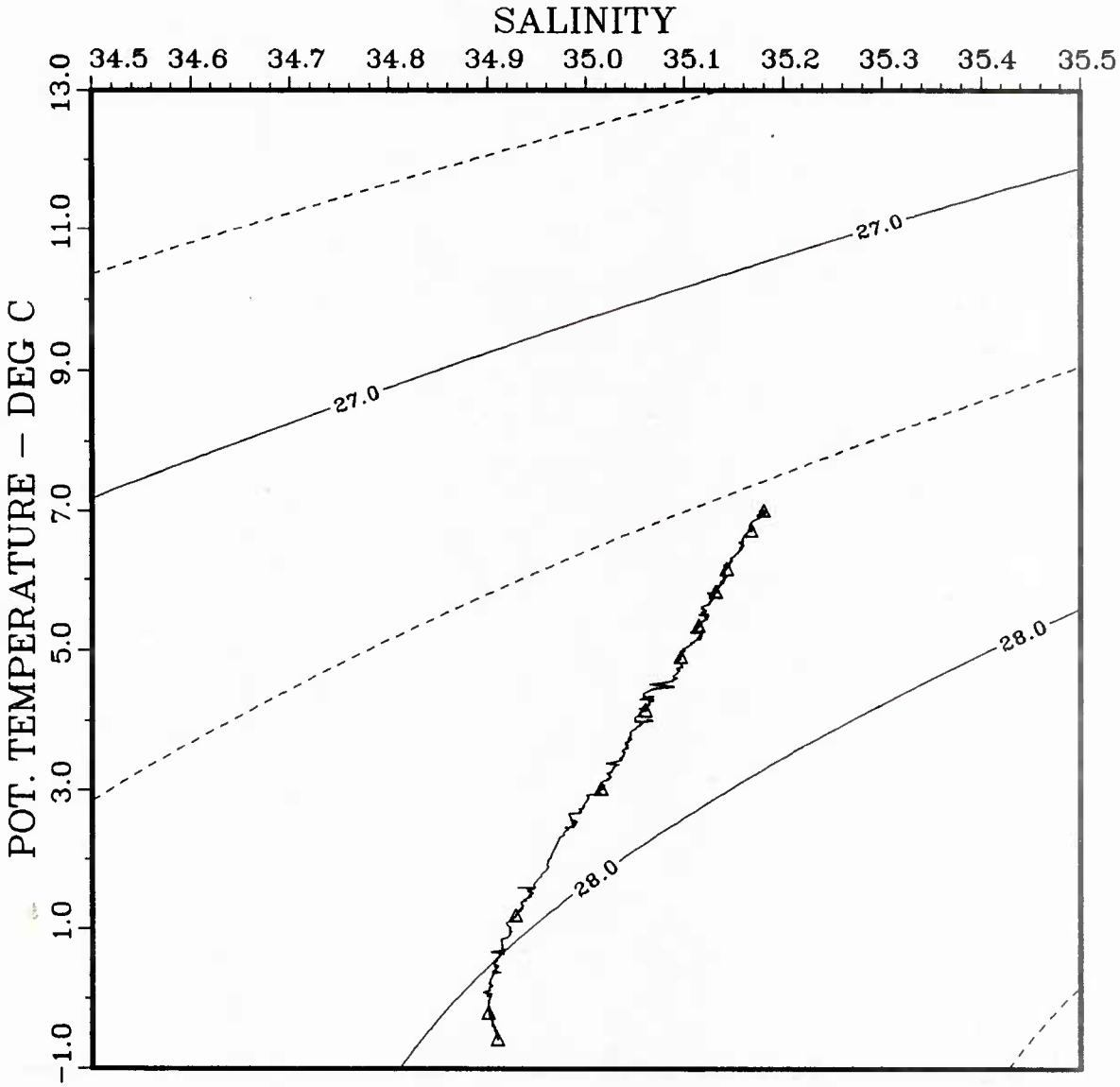
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 26 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.1820 | |
| LATITUDE | 66 58.08N | |
| LONGITUDE | 005 04.36E | |

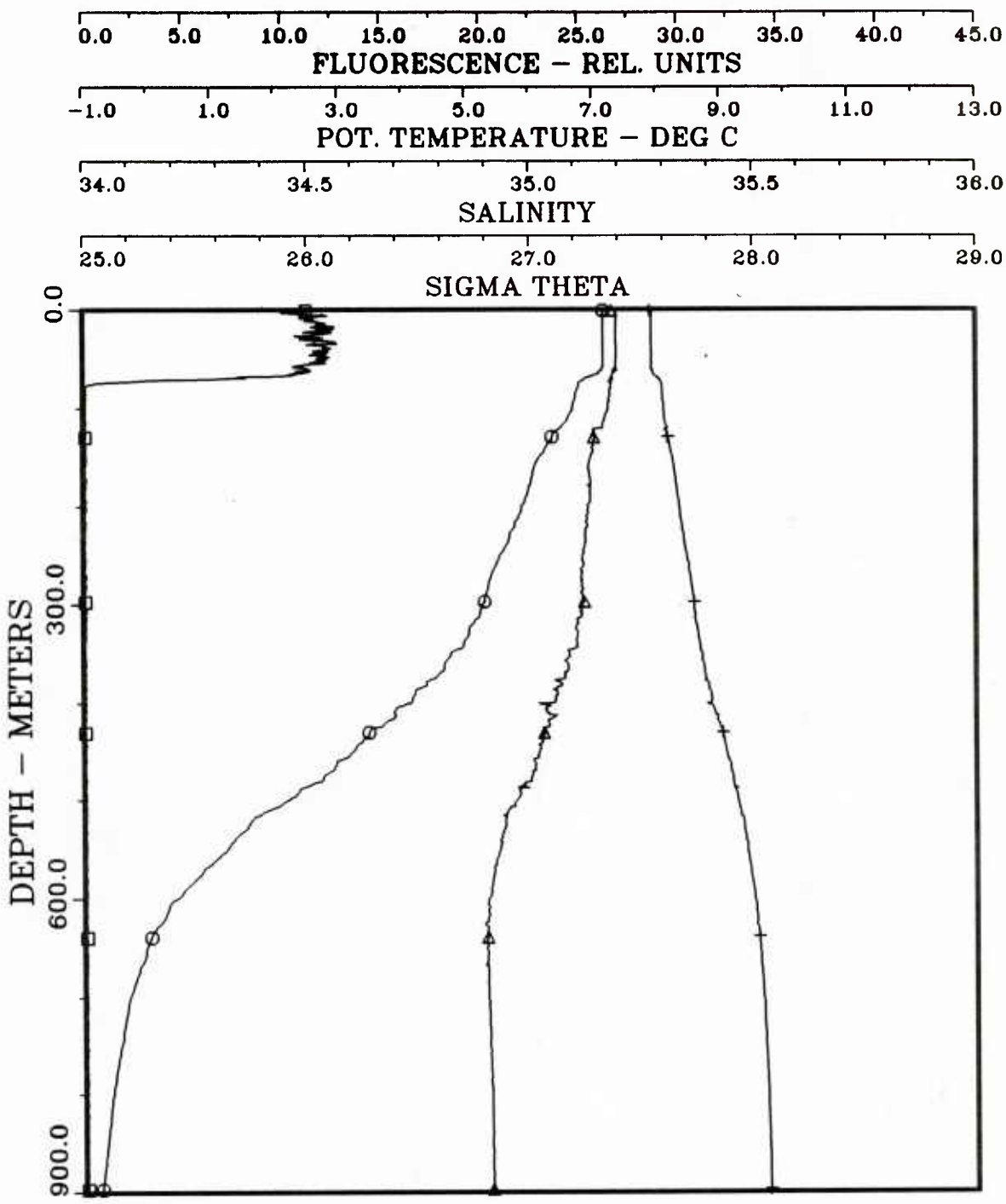



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 27 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.2100 | |
| LATITUDE | 67 10.68N | |
| LONGITUDE | 004 23.95E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 27 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.2100 | |
| LATITUDE | 67 10.68N | |
| LONGITUDE | 004 23.95E | |

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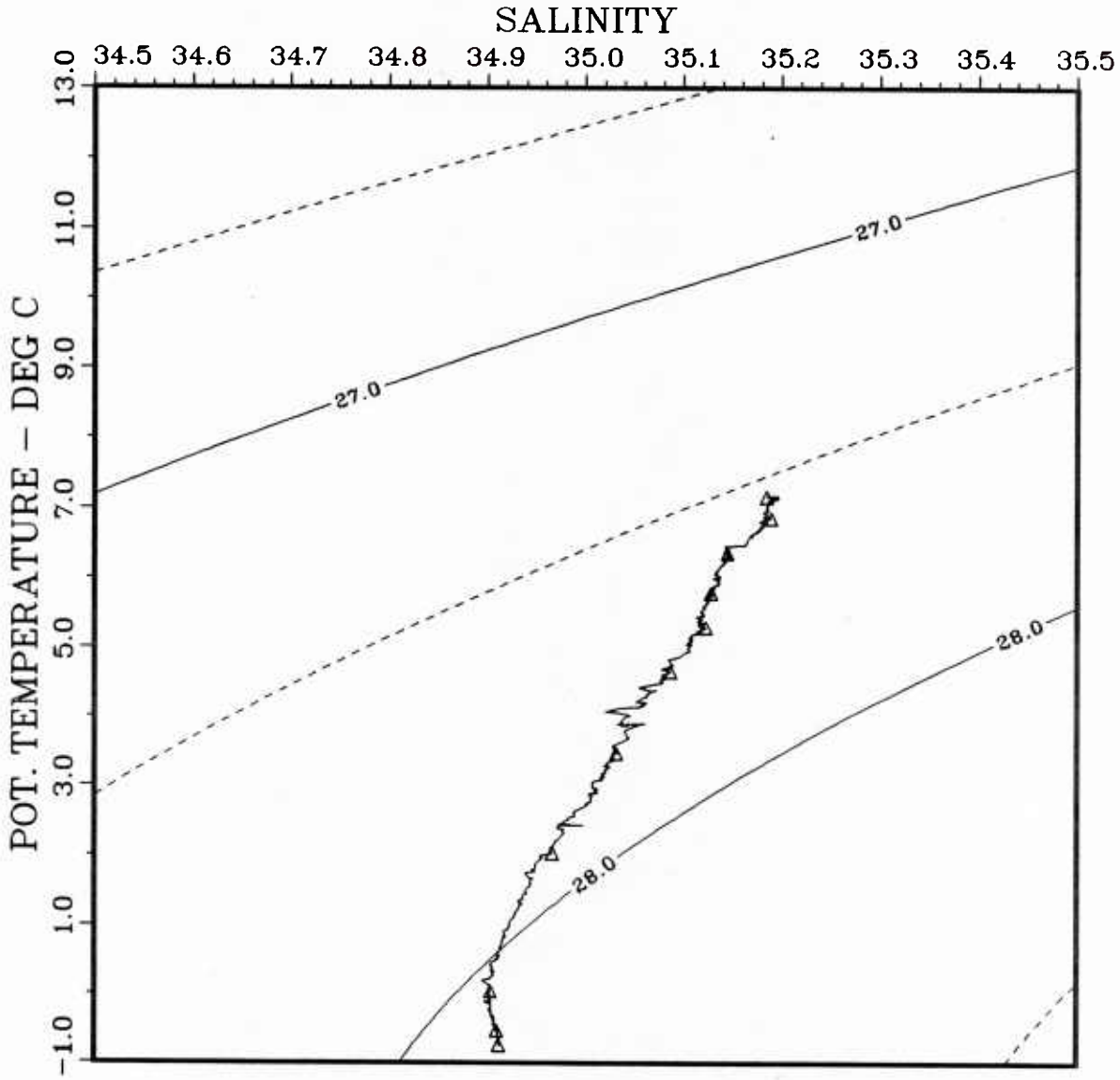
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 28 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.2350 | |
| LATITUDE | 66 23.50N | |
| LONGITUDE | 003 36.88E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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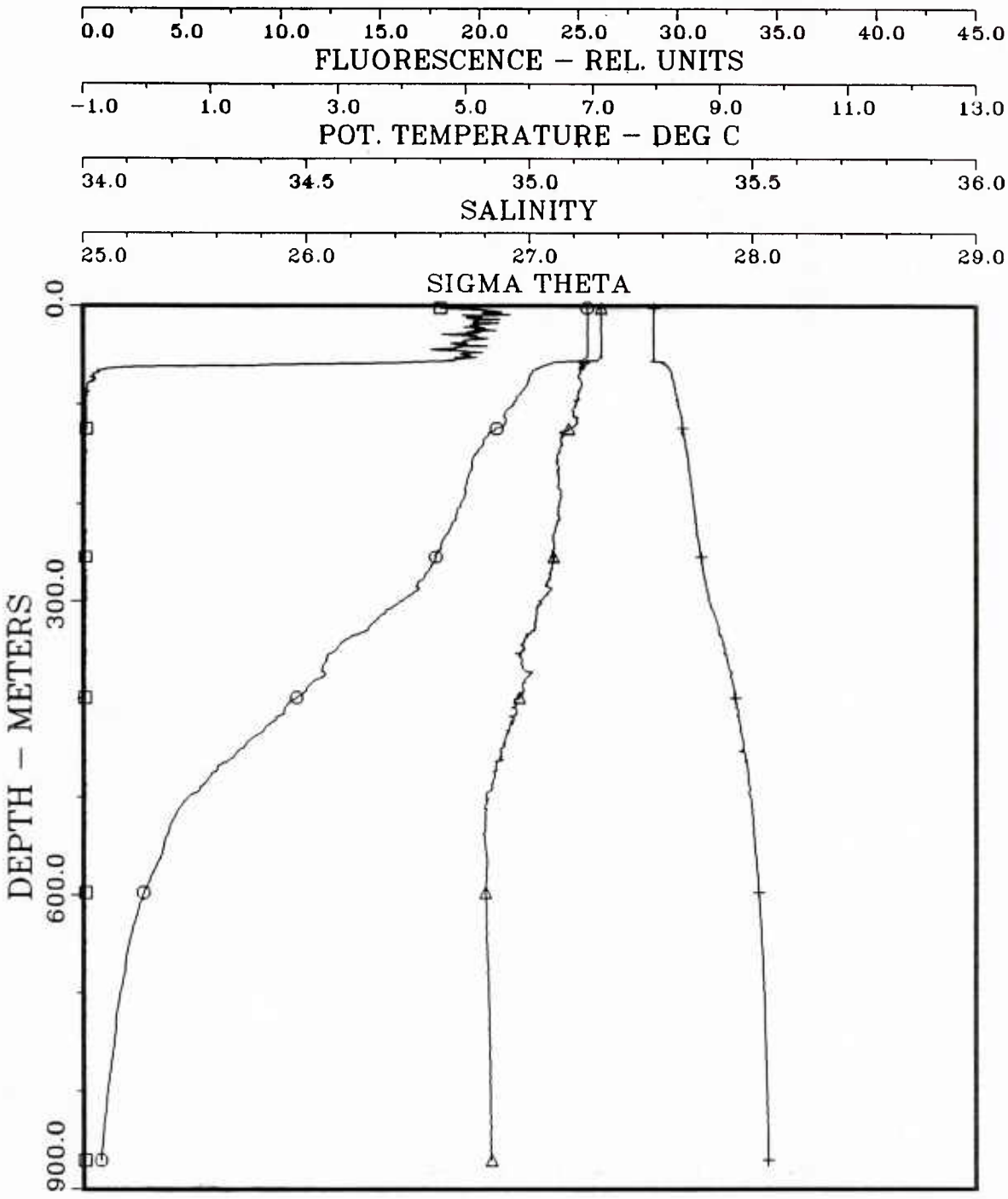
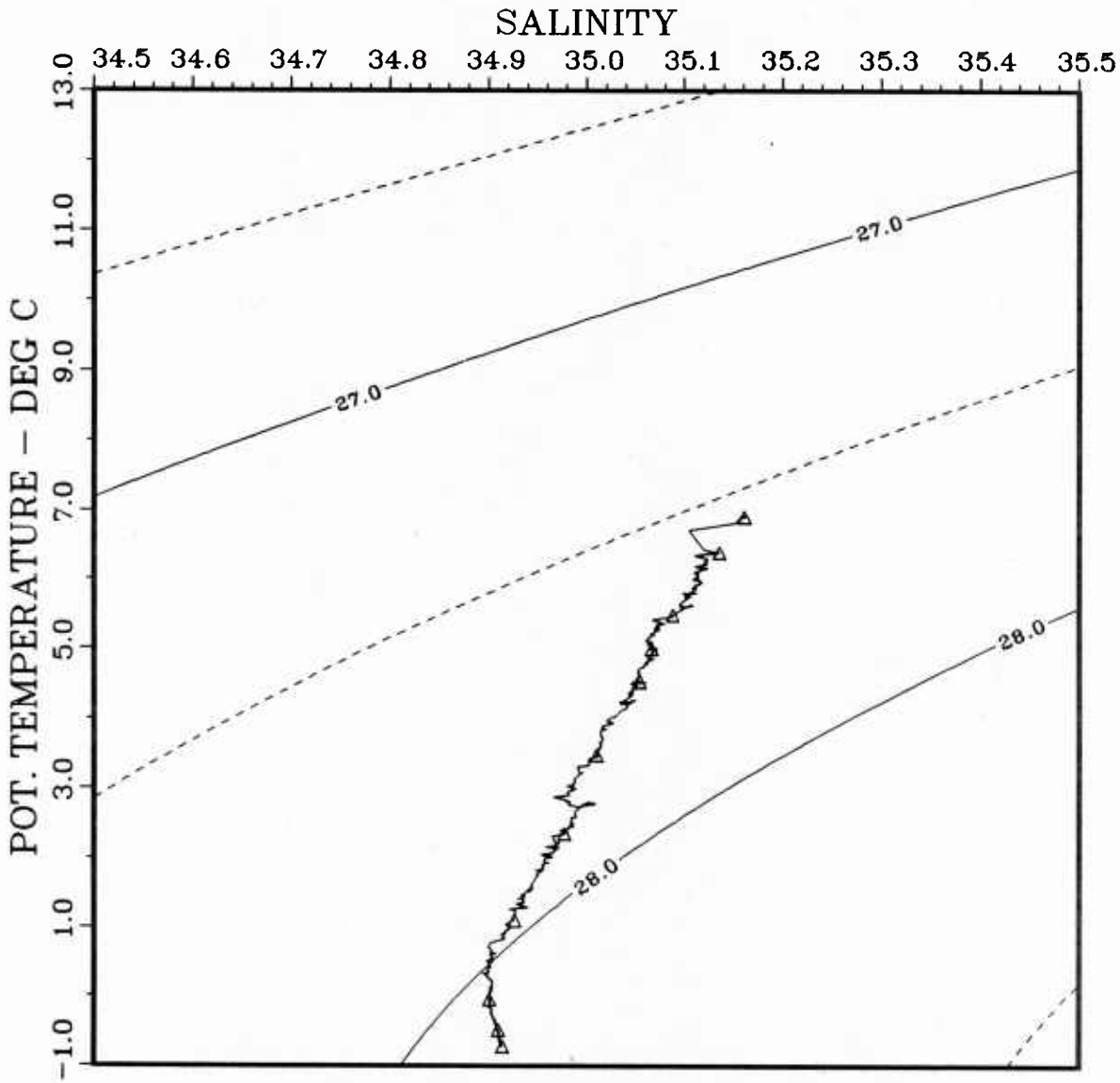
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 28 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 161.2350 | |
| LATITUDE | 66 23.50N | |
| LONGITUDE | 003 36.88E | |

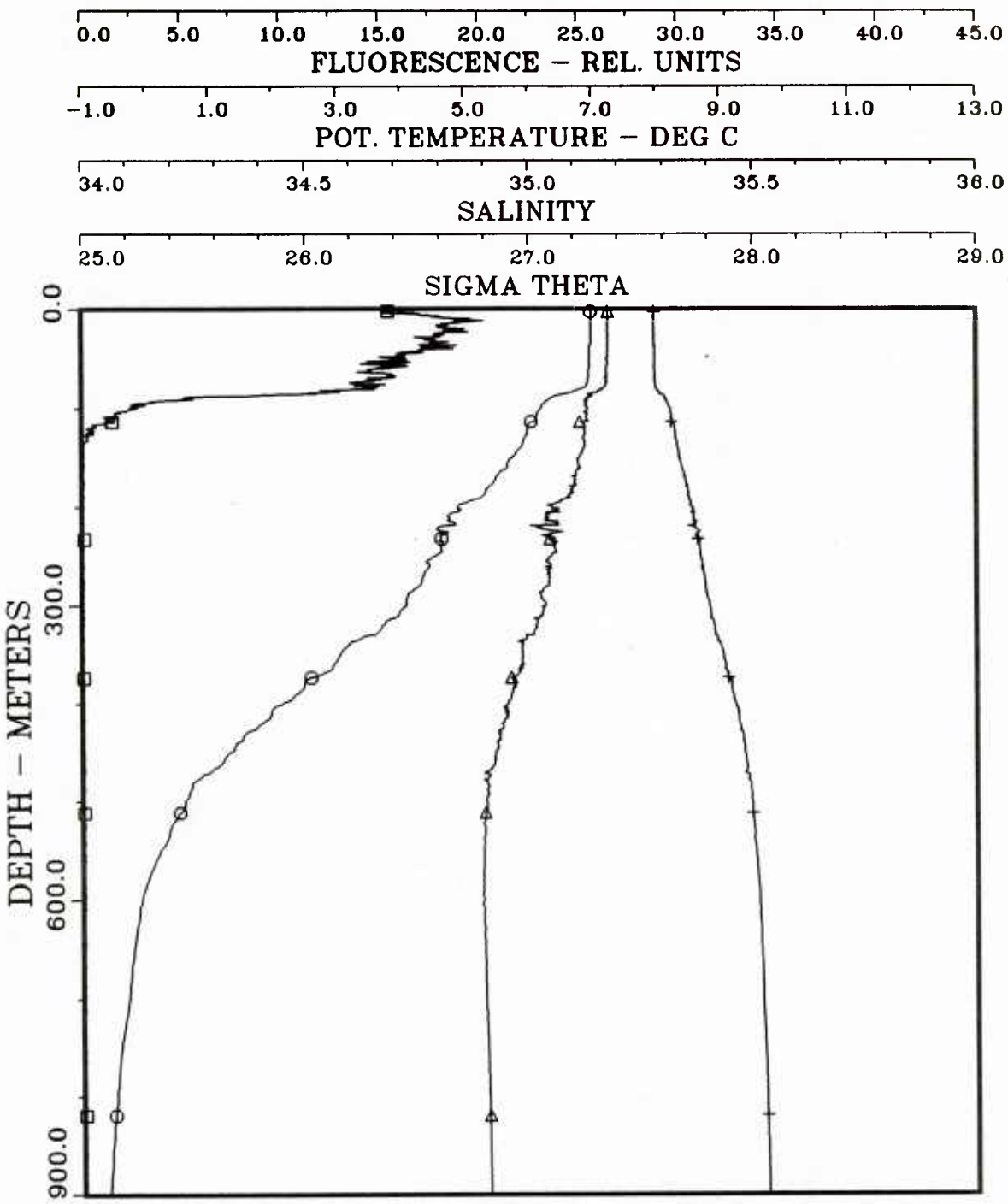



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 29 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0230 | |
| LATITUDE | 67 35.04N | |
| LONGITUDE | 002 57.28E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

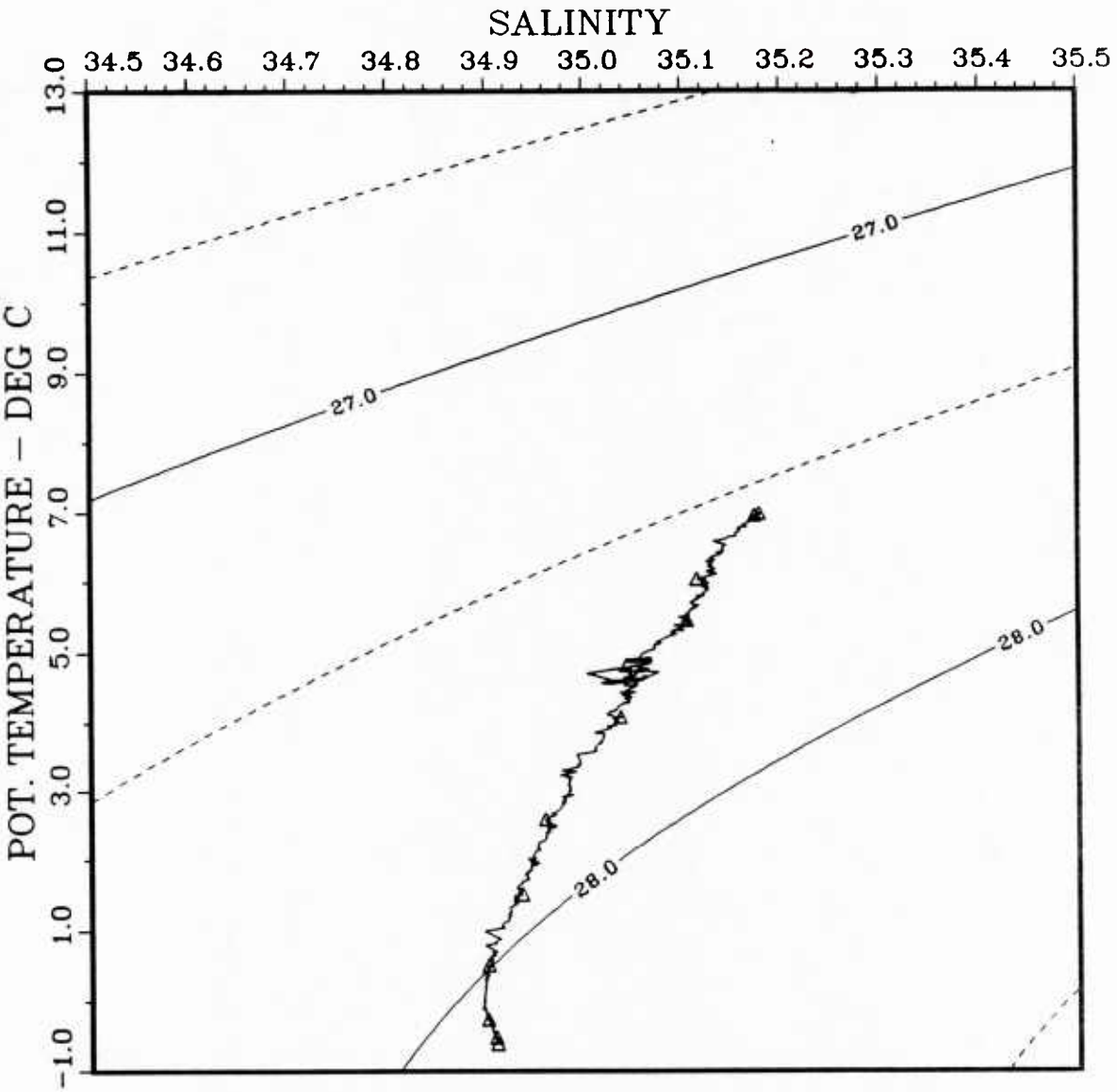



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 29 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0230 | |
| LATITUDE | 67 35.04N | |
| LONGITUDE | 002 57.28E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 30 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0520 | |
| LATITUDE | 67 47.44N | |
| LONGITUDE | 002 13.42E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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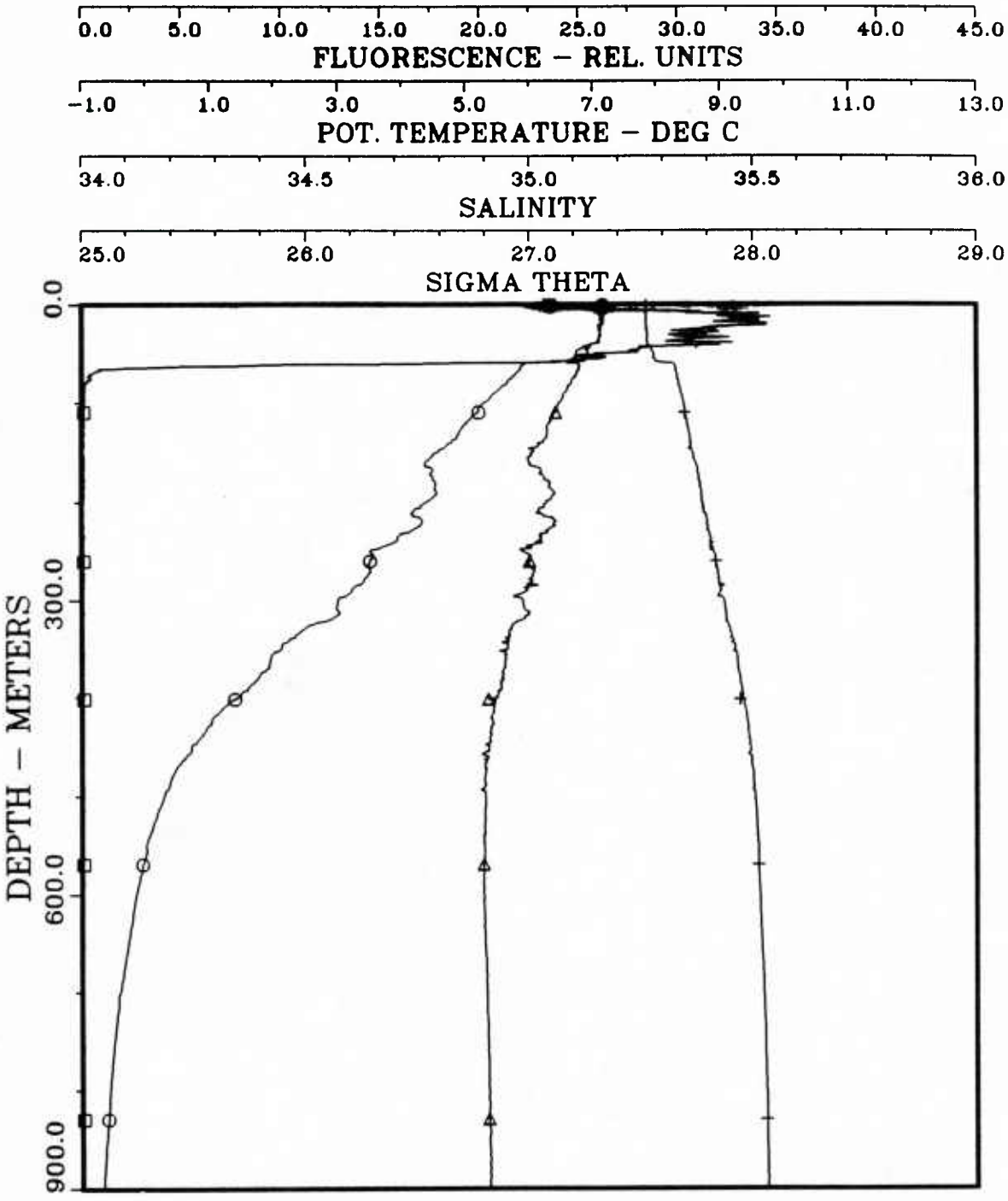
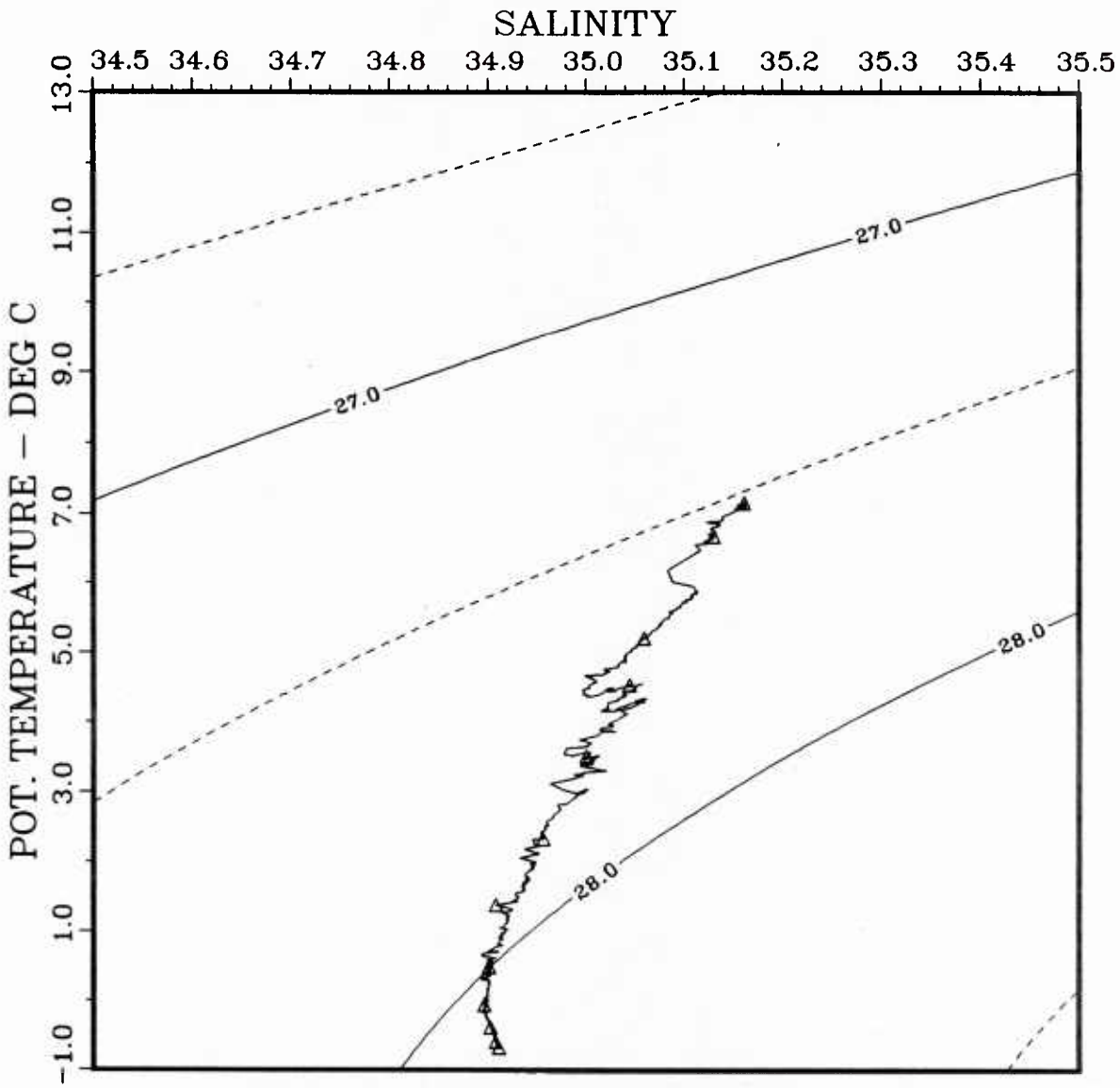
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 30 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0520 | |
| LATITUDE | 67 47.44N | |
| LONGITUDE | 002 13.42E | |

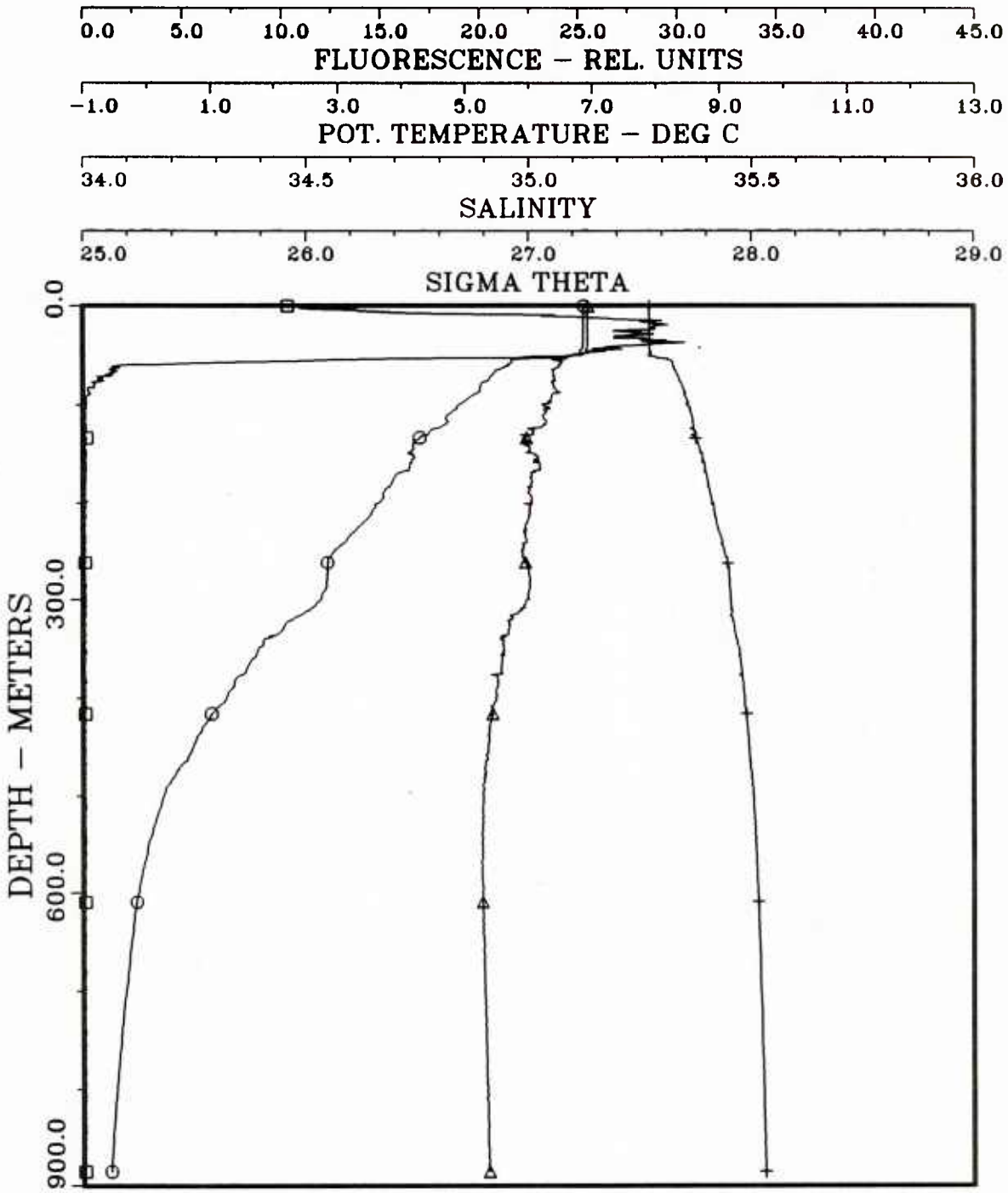



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 31 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0630 | |
| LATITUDE | 67 51.12N | |
| LONGITUDE | 001 58.11E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

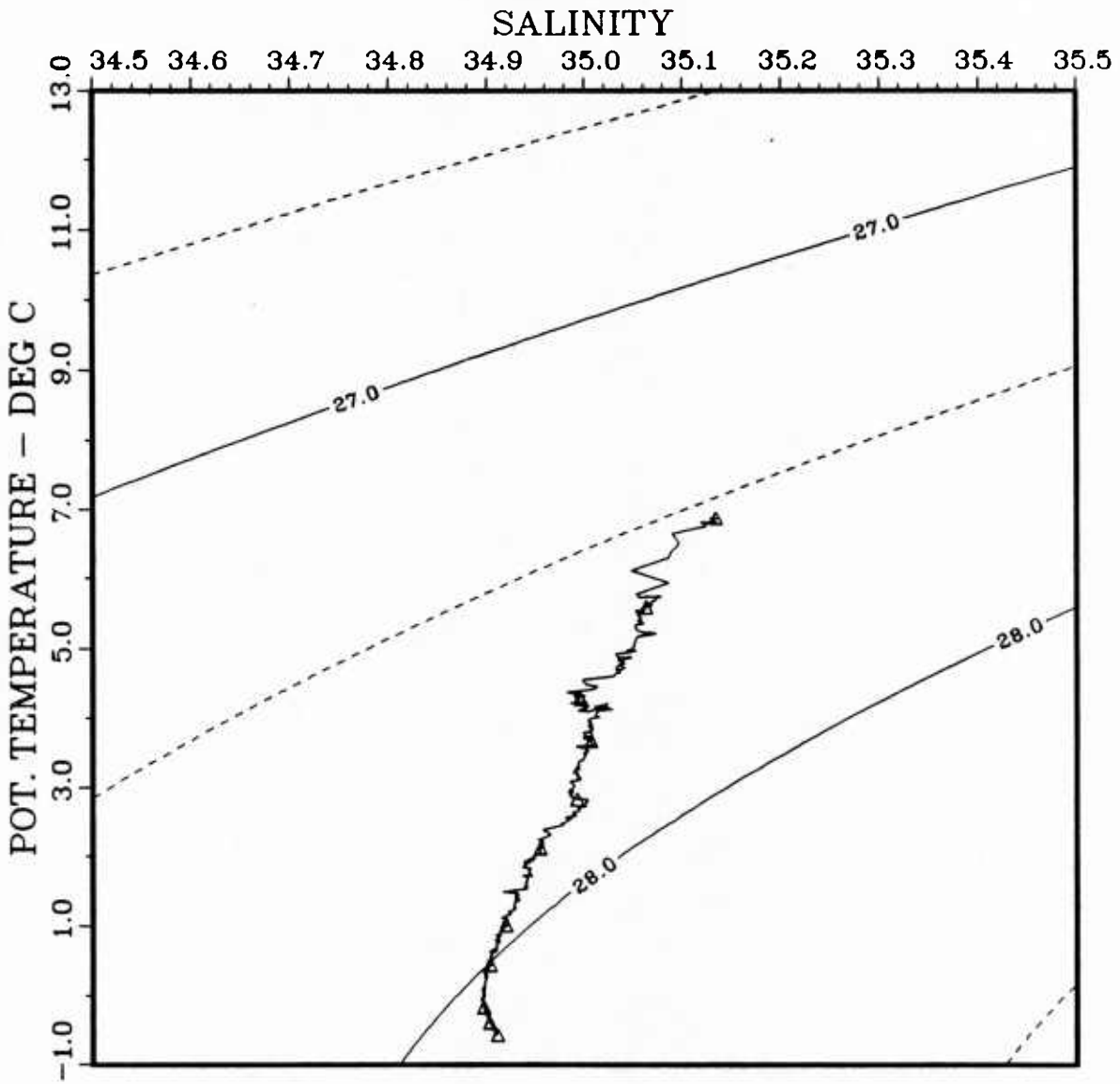



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 31 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0630 | |
| LATITUDE | 67 51.12N | |
| LONGITUDE | 001 58.11E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 32 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0830 | |
| LATITUDE | 67 58.01N | |
| LONGITUDE | 001 22.65E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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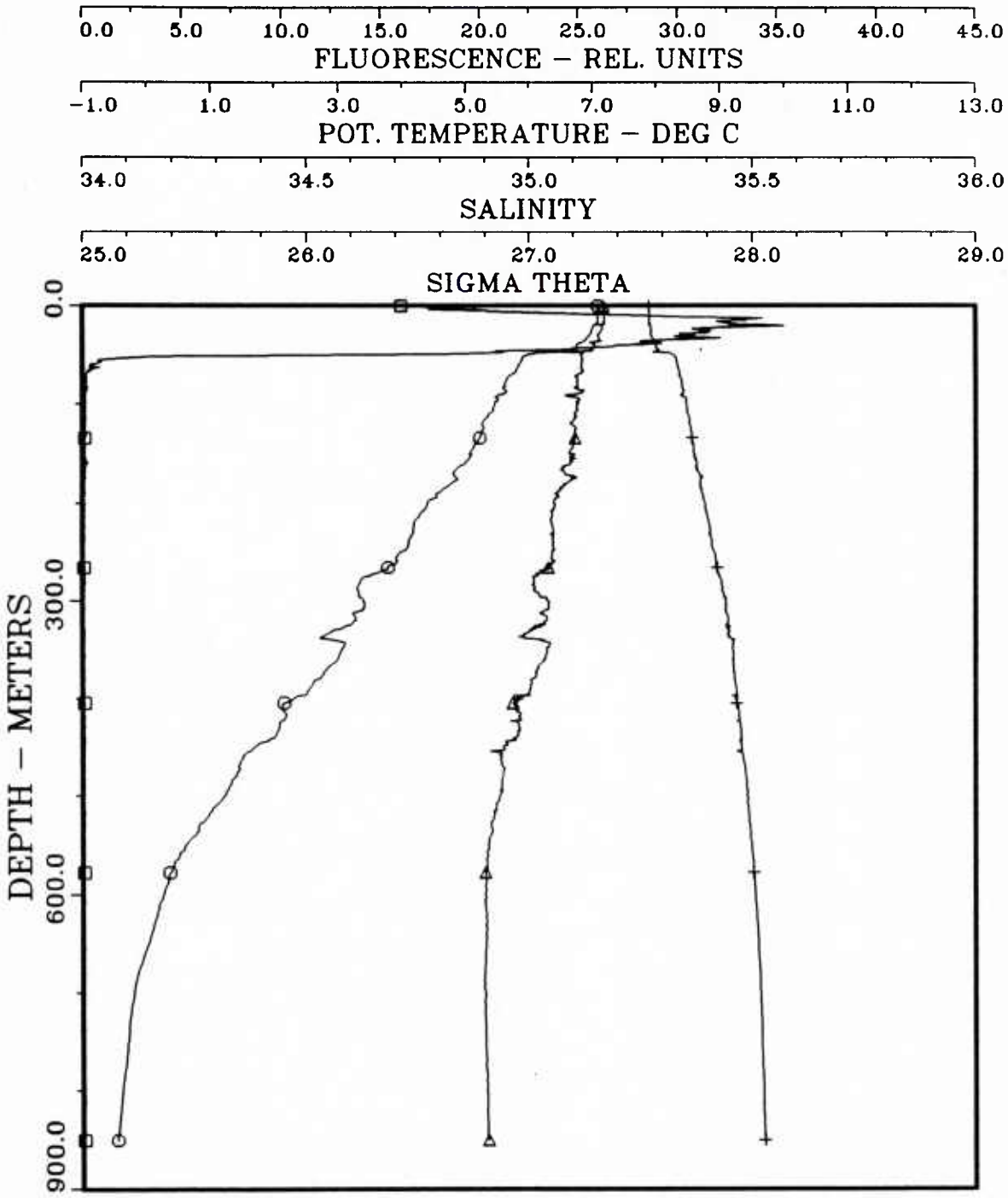
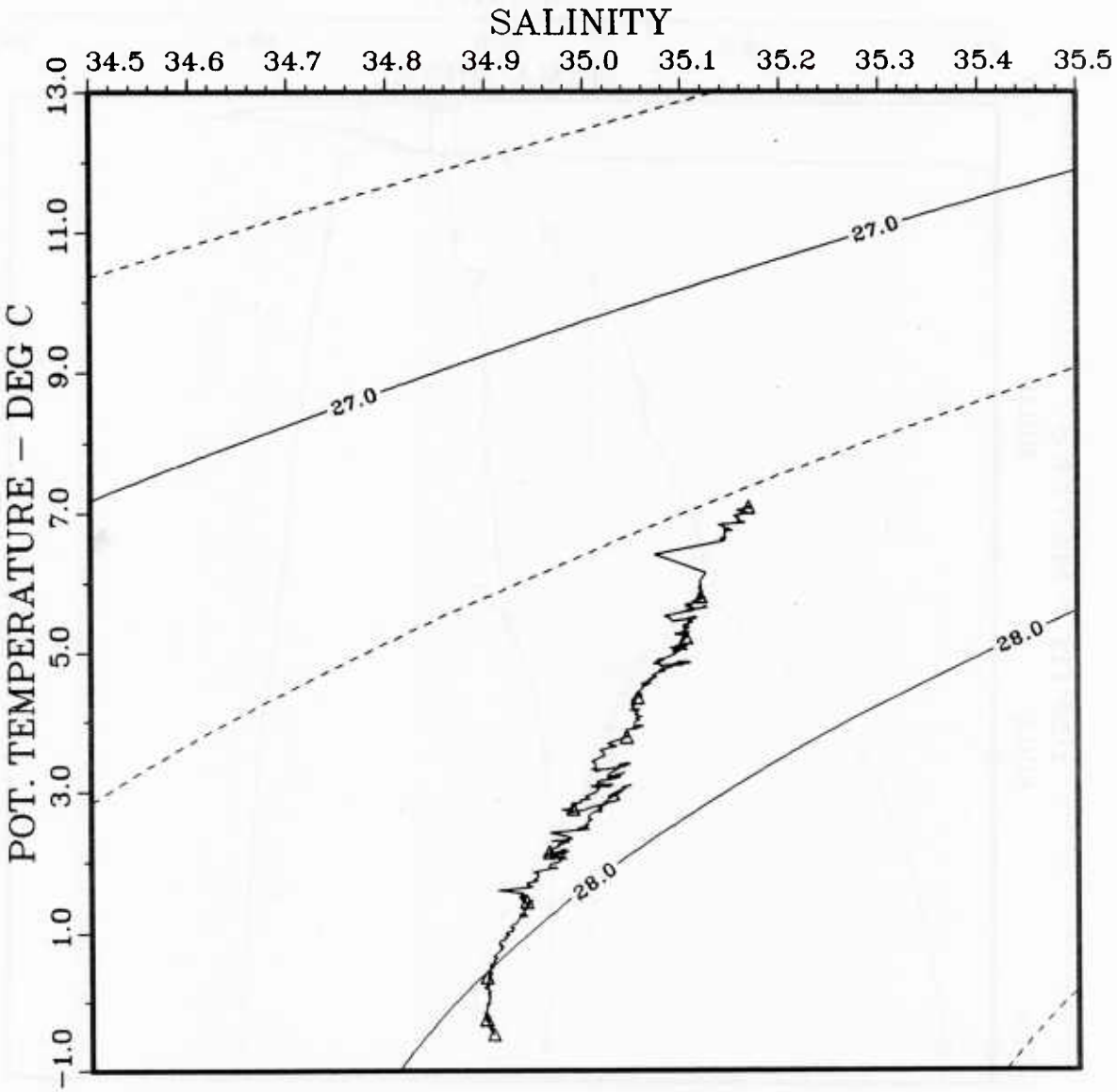
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 32 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.0830 | |
| LATITUDE | 67 58.01N | |
| LONGITUDE | 001 22.65E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 33 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.1110 | |
| LATITUDE | 68 10.56N | |
| LONGITUDE | 000 50.02E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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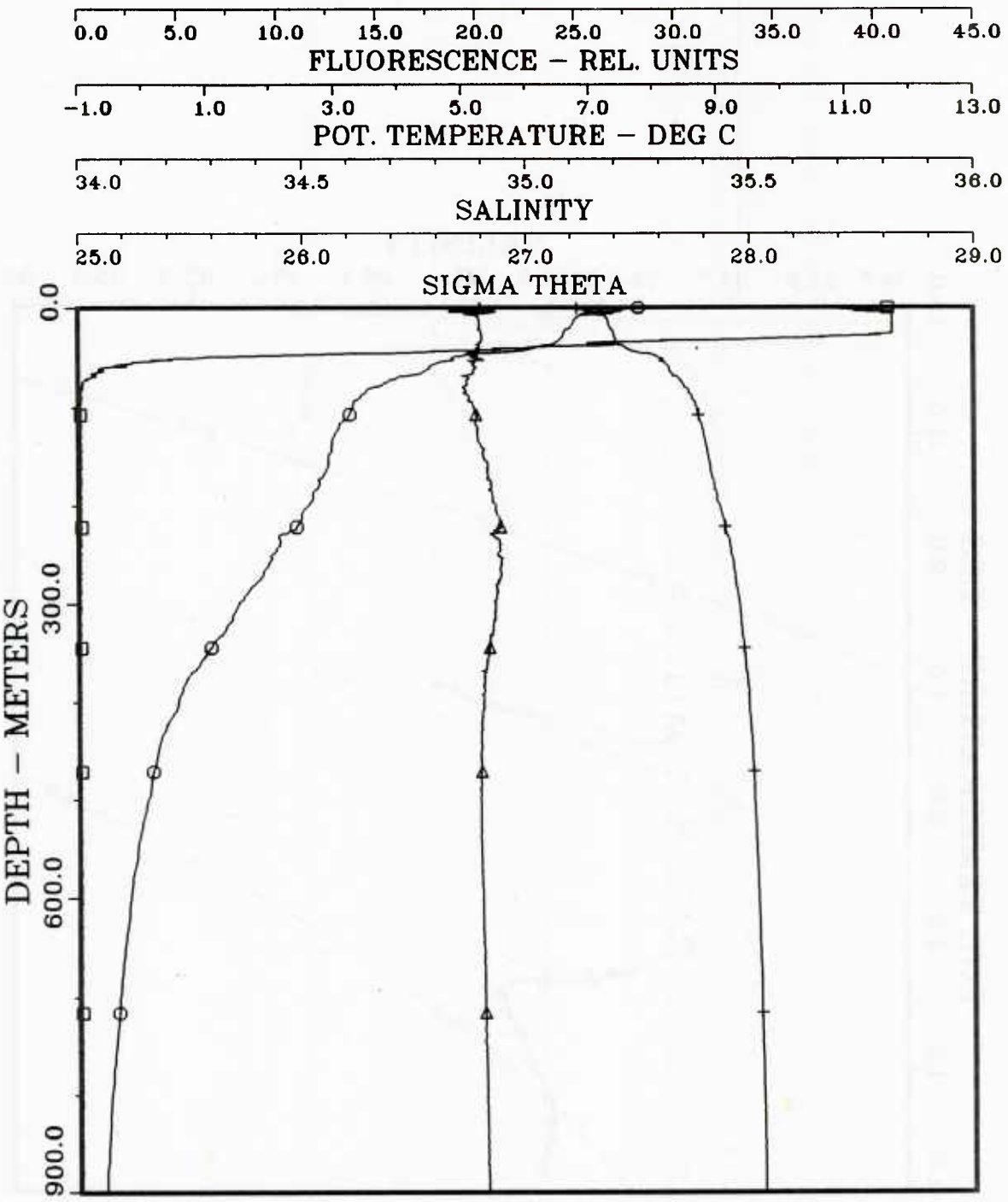
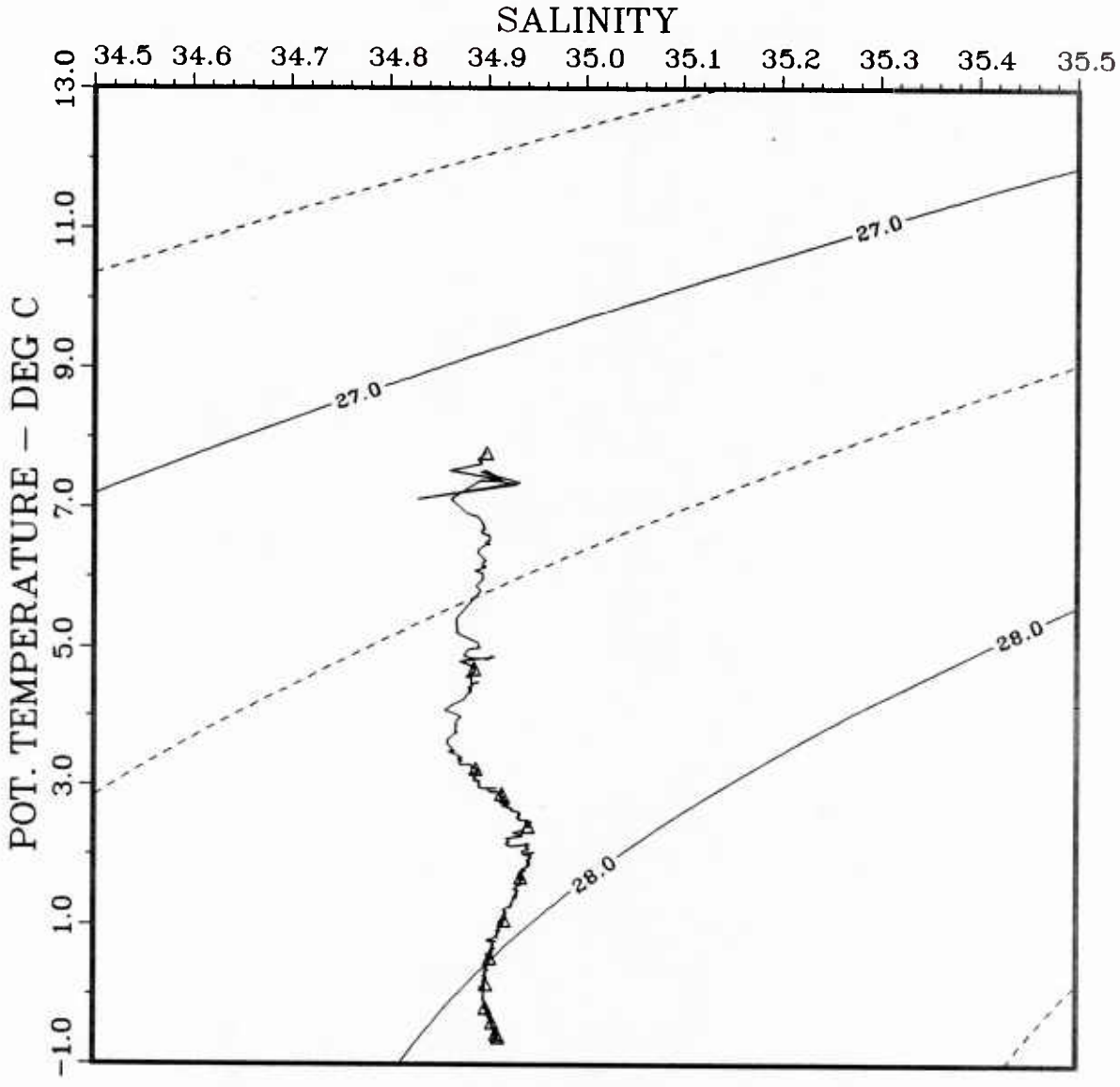
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 33 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 162.1110 | |
| LATITUDE | 68 10.56N | |
| LONGITUDE | 000 50.02E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 36 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 166.2100 | |
| LATITUDE | 64 20.30N | |
| LONGITUDE | 004 59.44W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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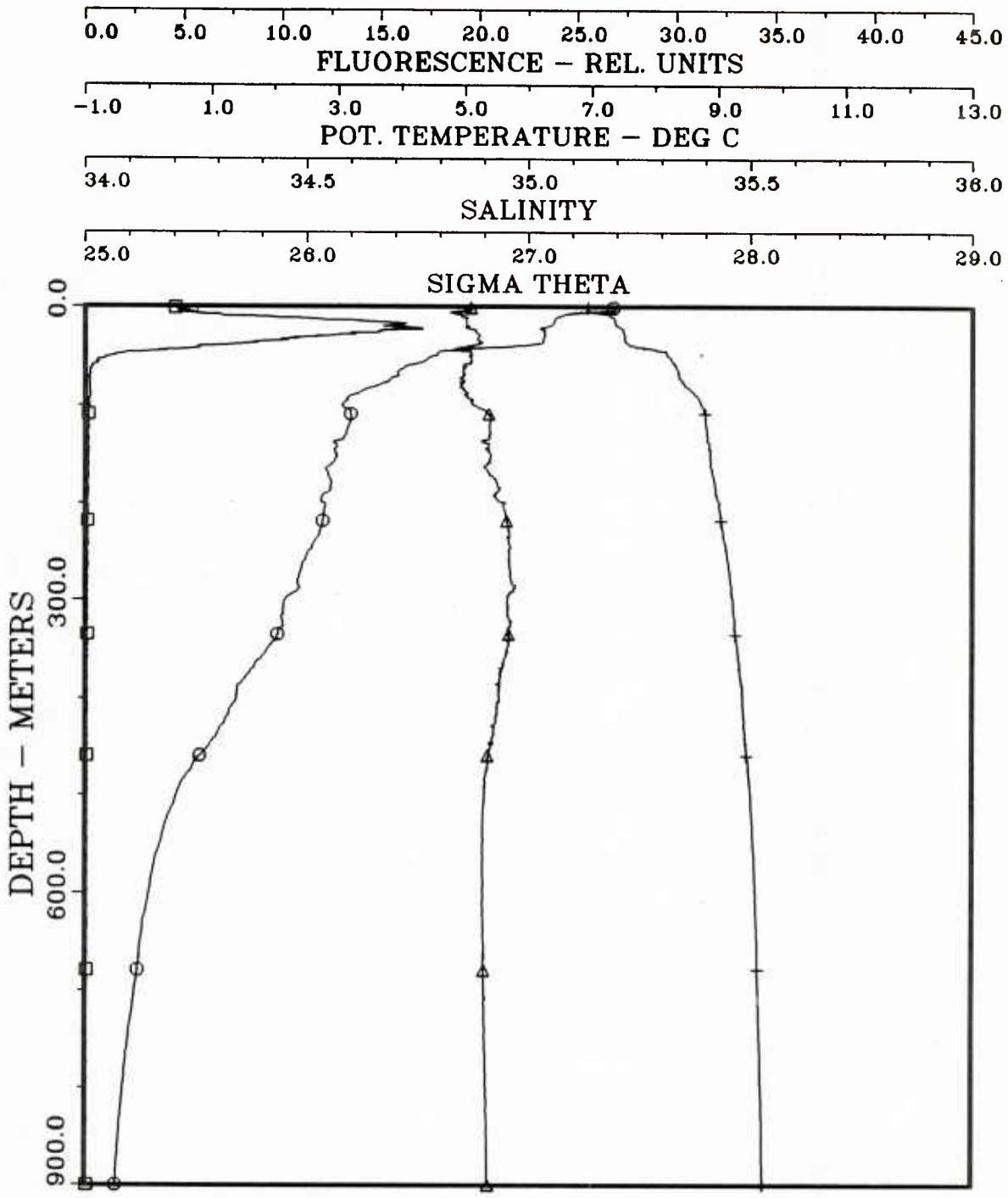
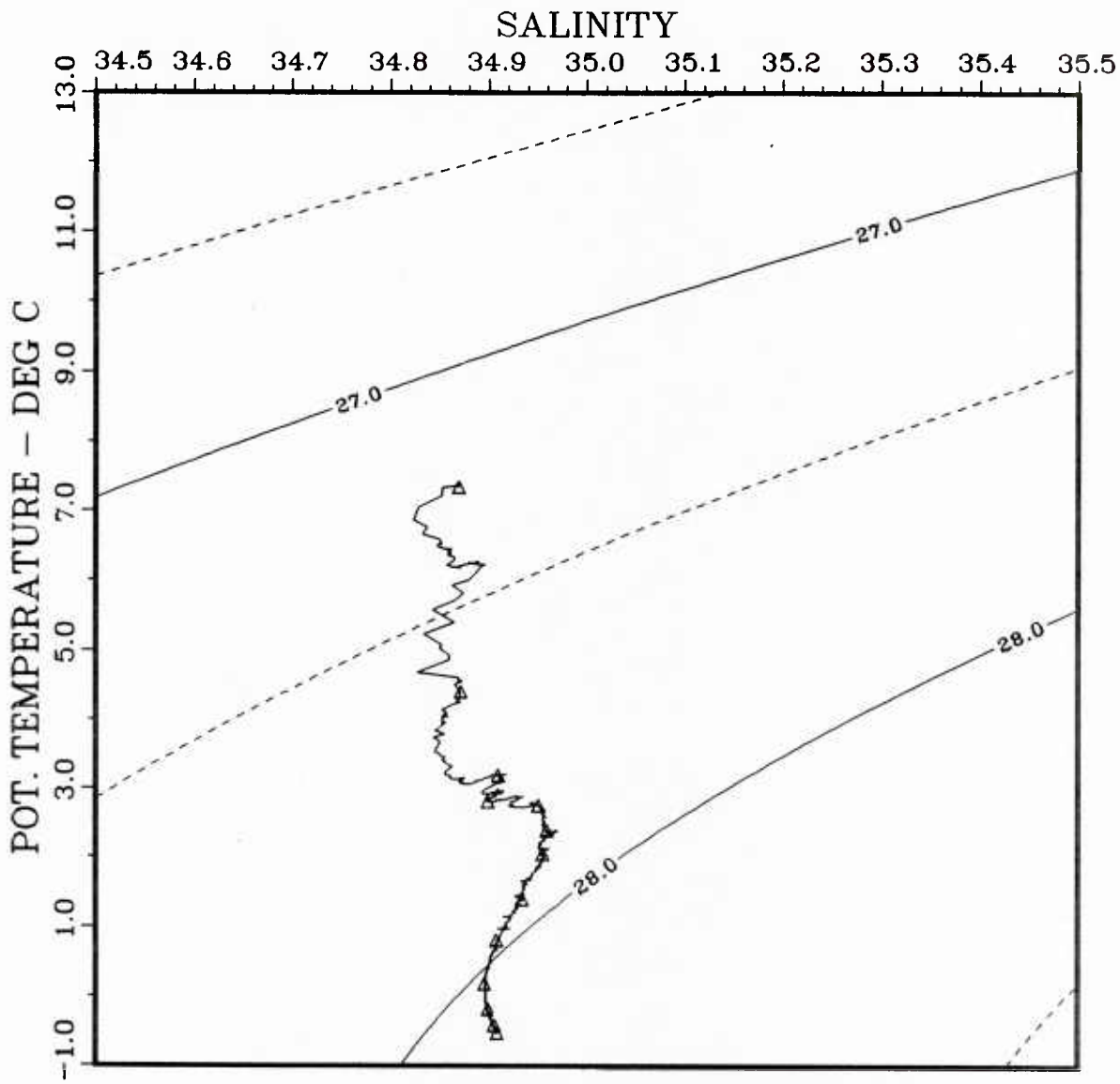
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 36 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 166.2100 | |
| LATITUDE | 64 20.30N | |
| LONGITUDE | 004 59.44W | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 37 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0010 | |
| LATITUDE | 64 43.65N | |
| LONGITUDE | 004 34.00W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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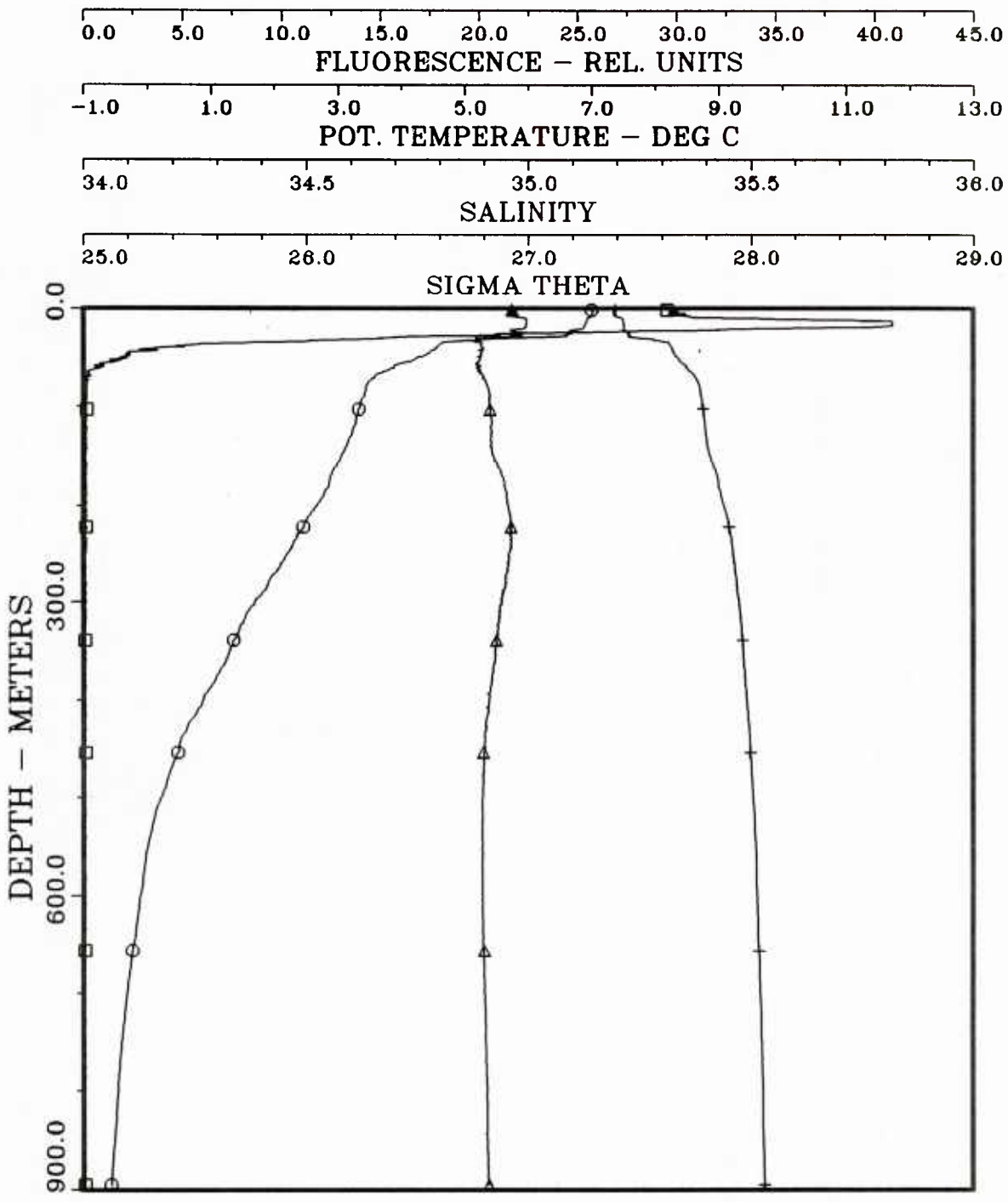
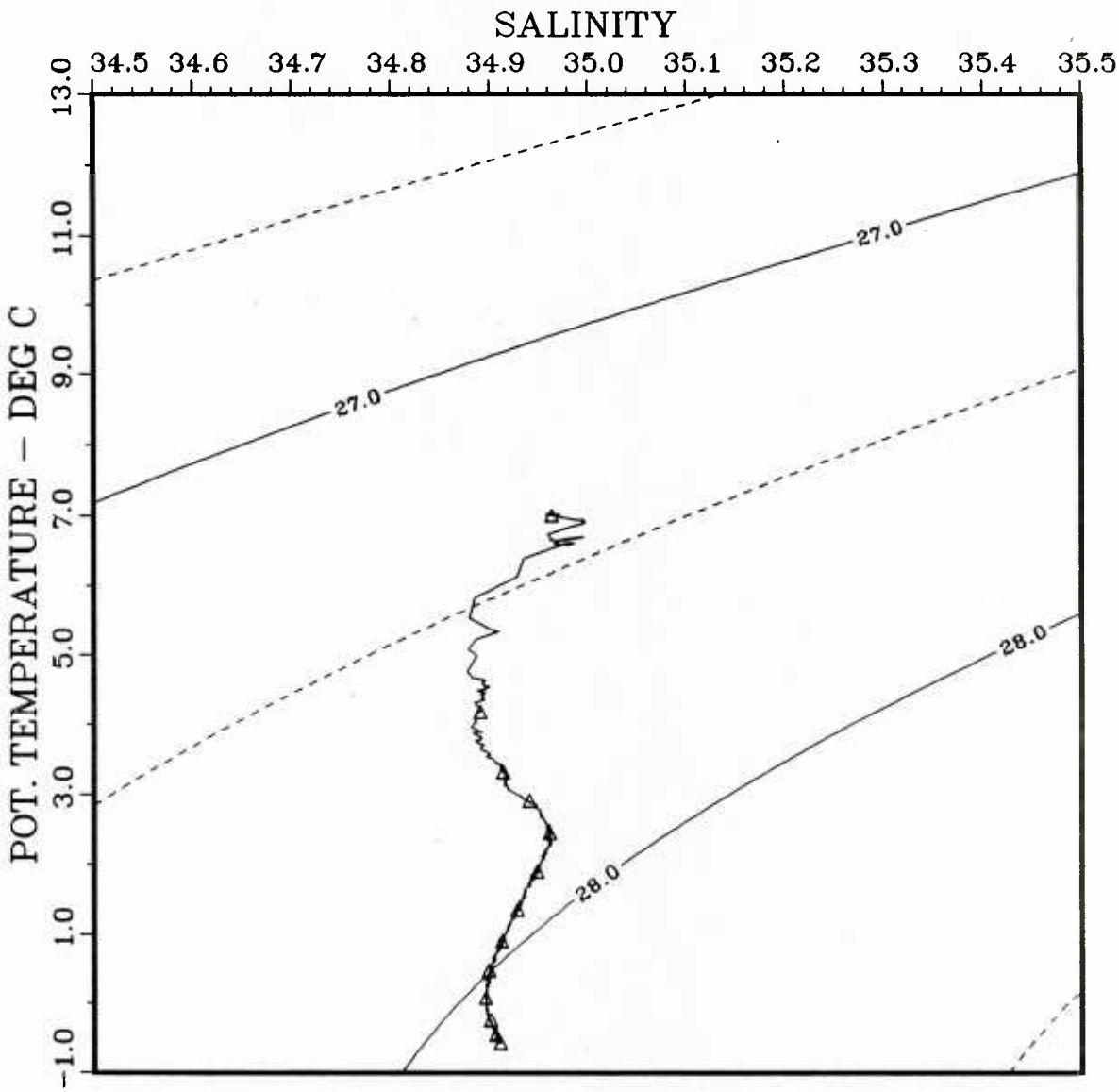
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 37 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0010 | |
| LATITUDE | 64 43.65N | |
| LONGITUDE | 004 34.00W | |

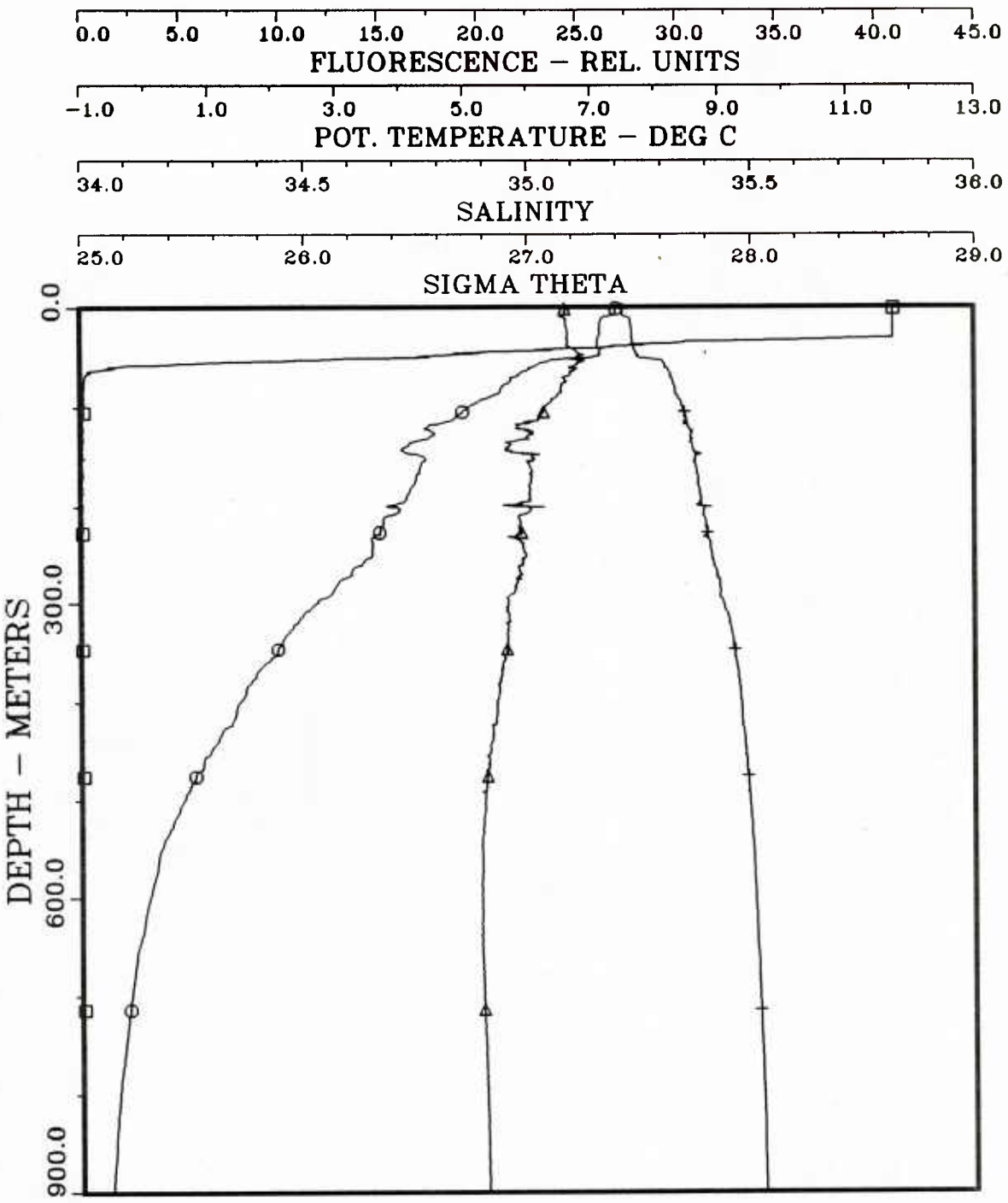



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 38 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0310 | |
| LATITUDE | 65 07.28N | |
| LONGITUDE | 004 08.25W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

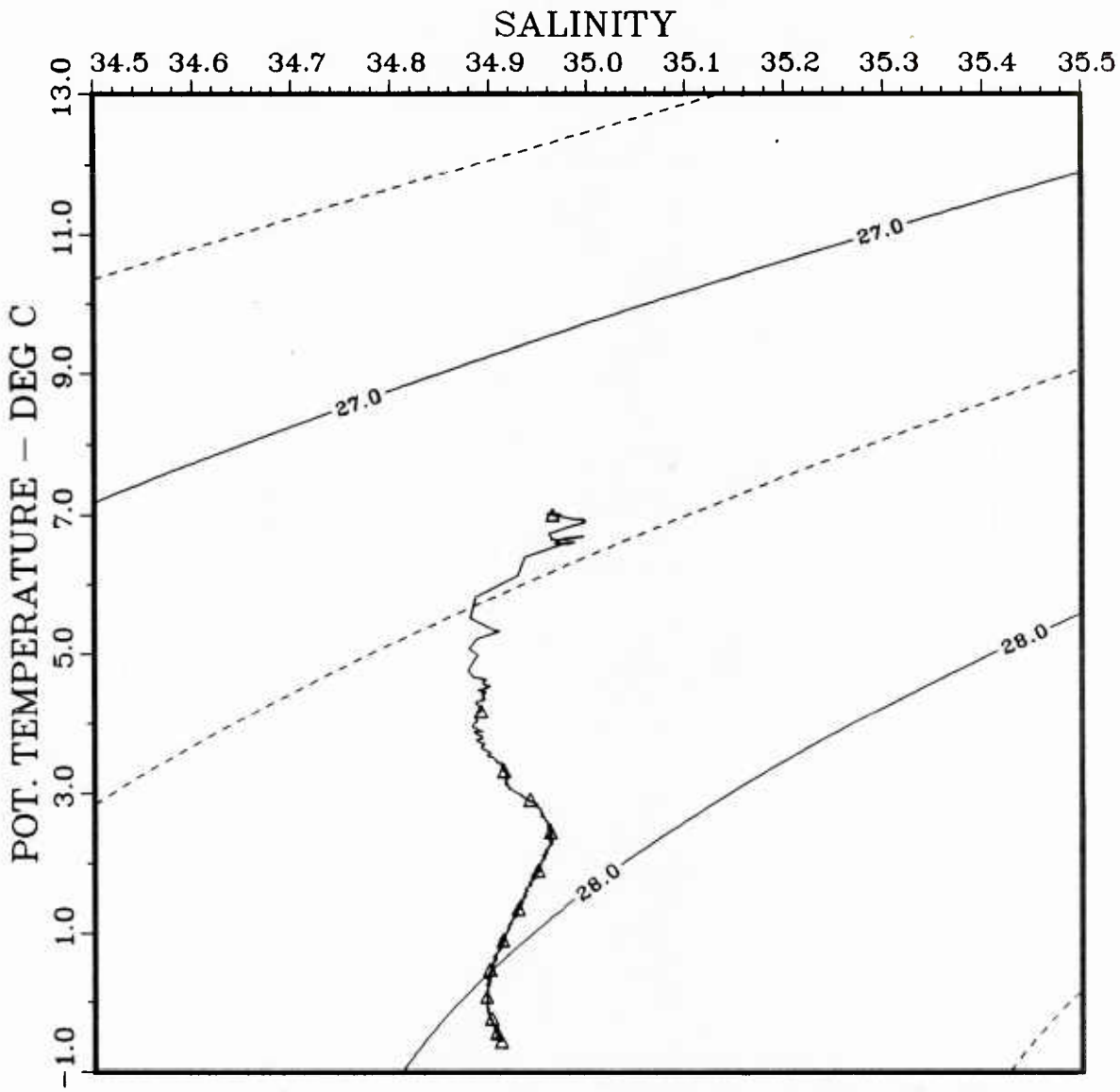



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 38 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0310 | |
| LATITUDE | 65 07.28N | |
| LONGITUDE | 004 08.25W | |

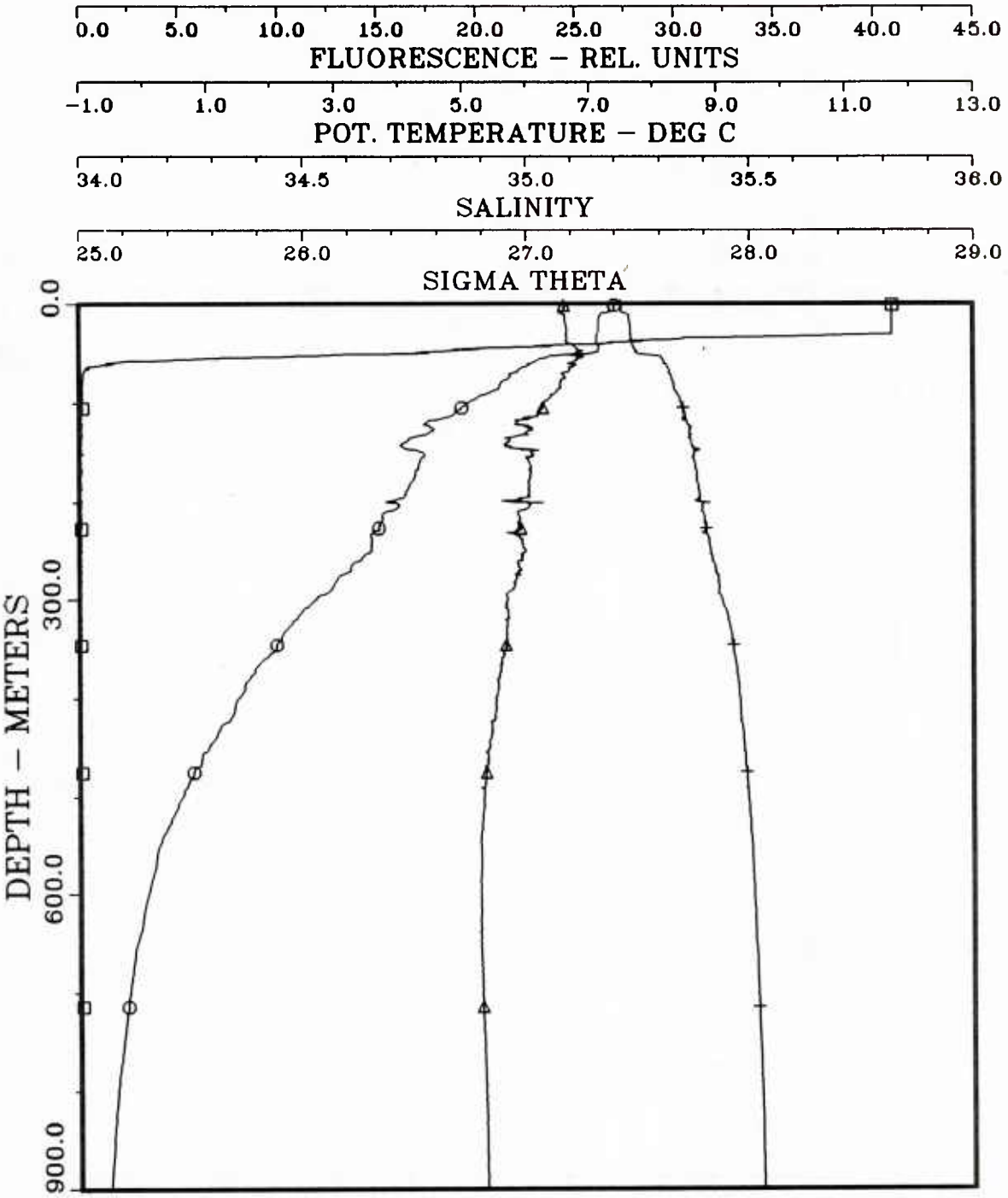



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 39 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0610 | |
| LATITUDE | 65 31.30N | |
| LONGITUDE | 003 36.81W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
+ = SIGMA THETA

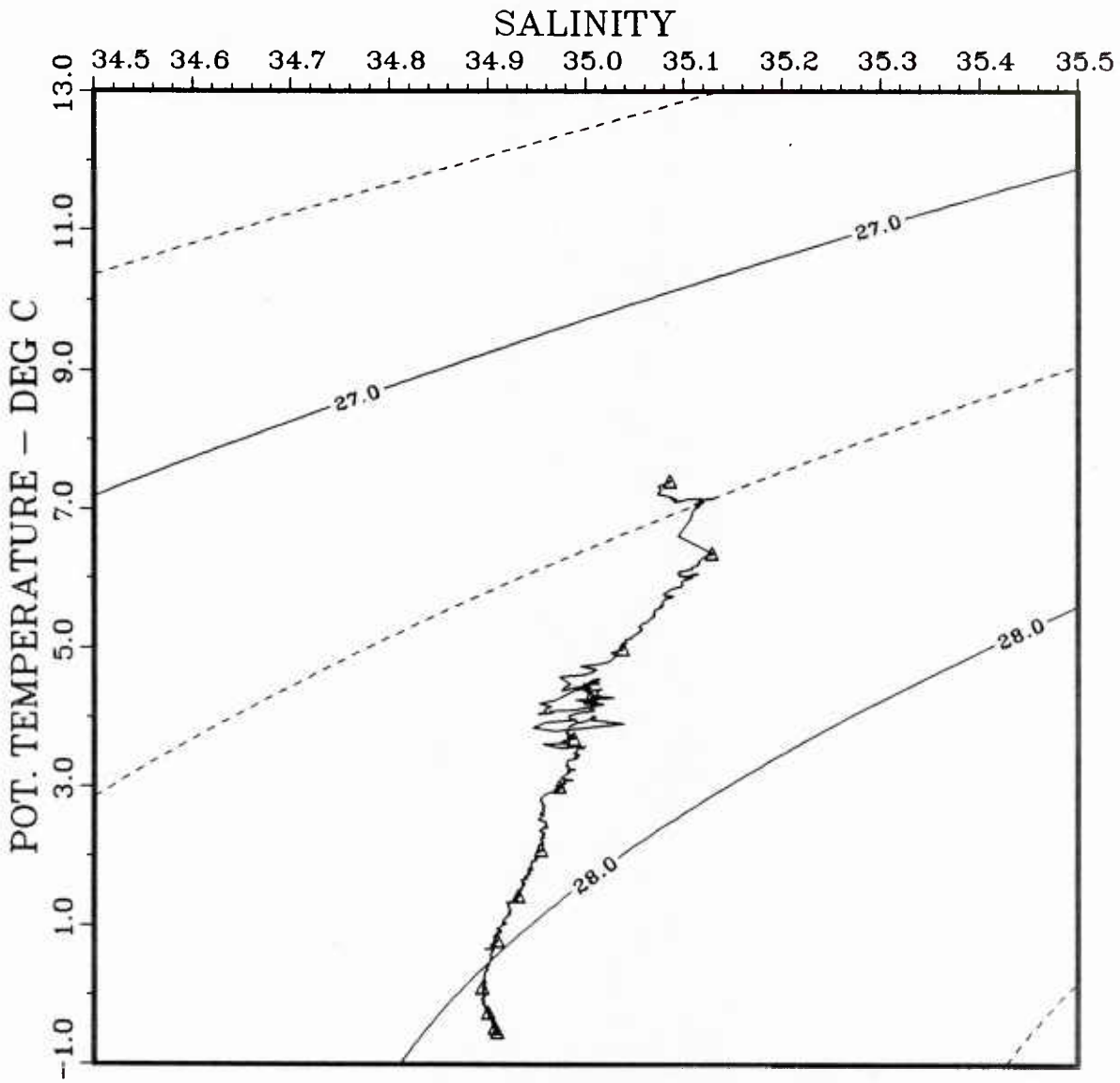



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 38 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0310 | |
| LATITUDE | 65 07.28N | |
| LONGITUDE | 004 08.25W | |

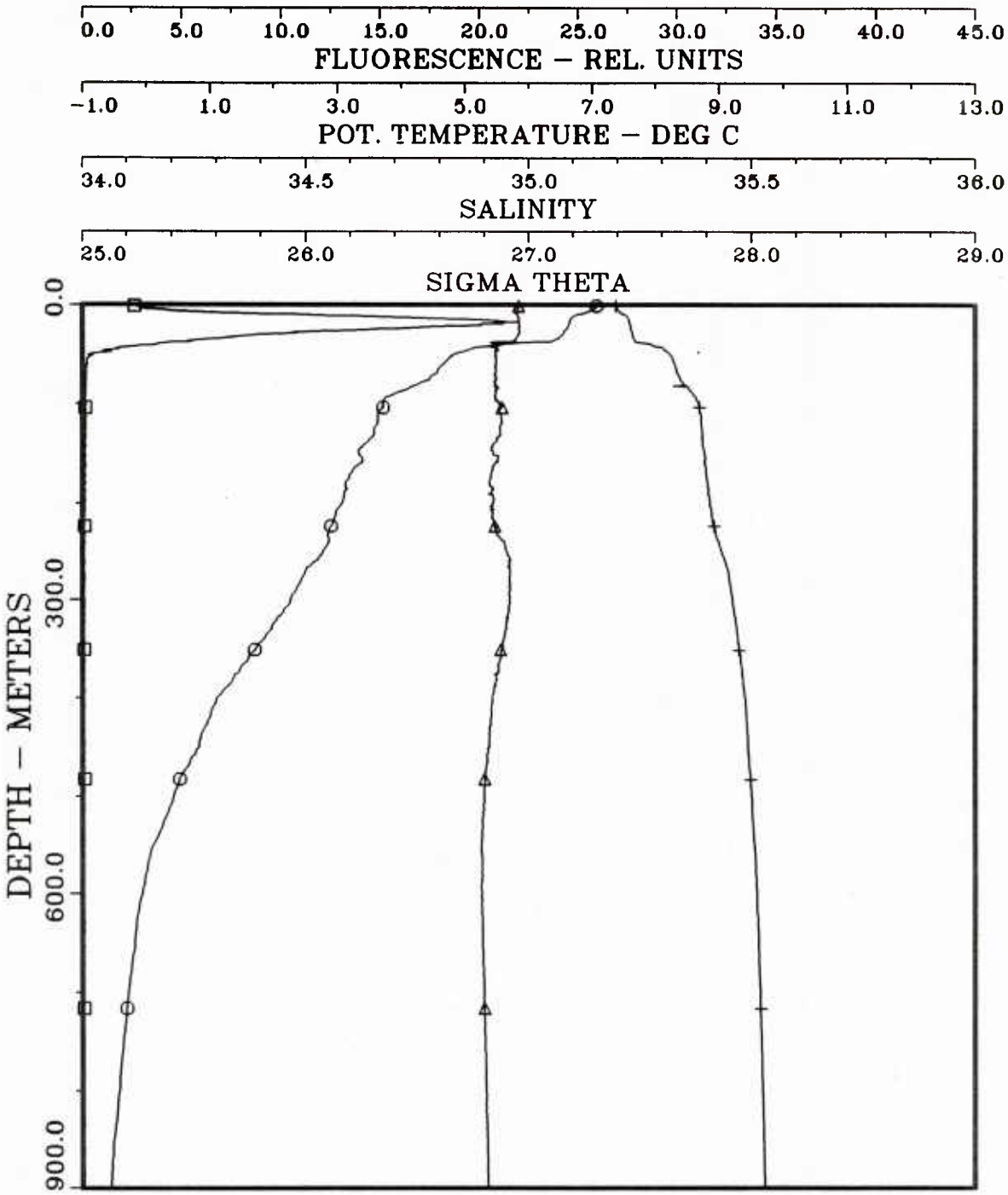



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 39 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0610 | |
| LATITUDE | 65 31.30N | |
| LONGITUDE | 003 36.81W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

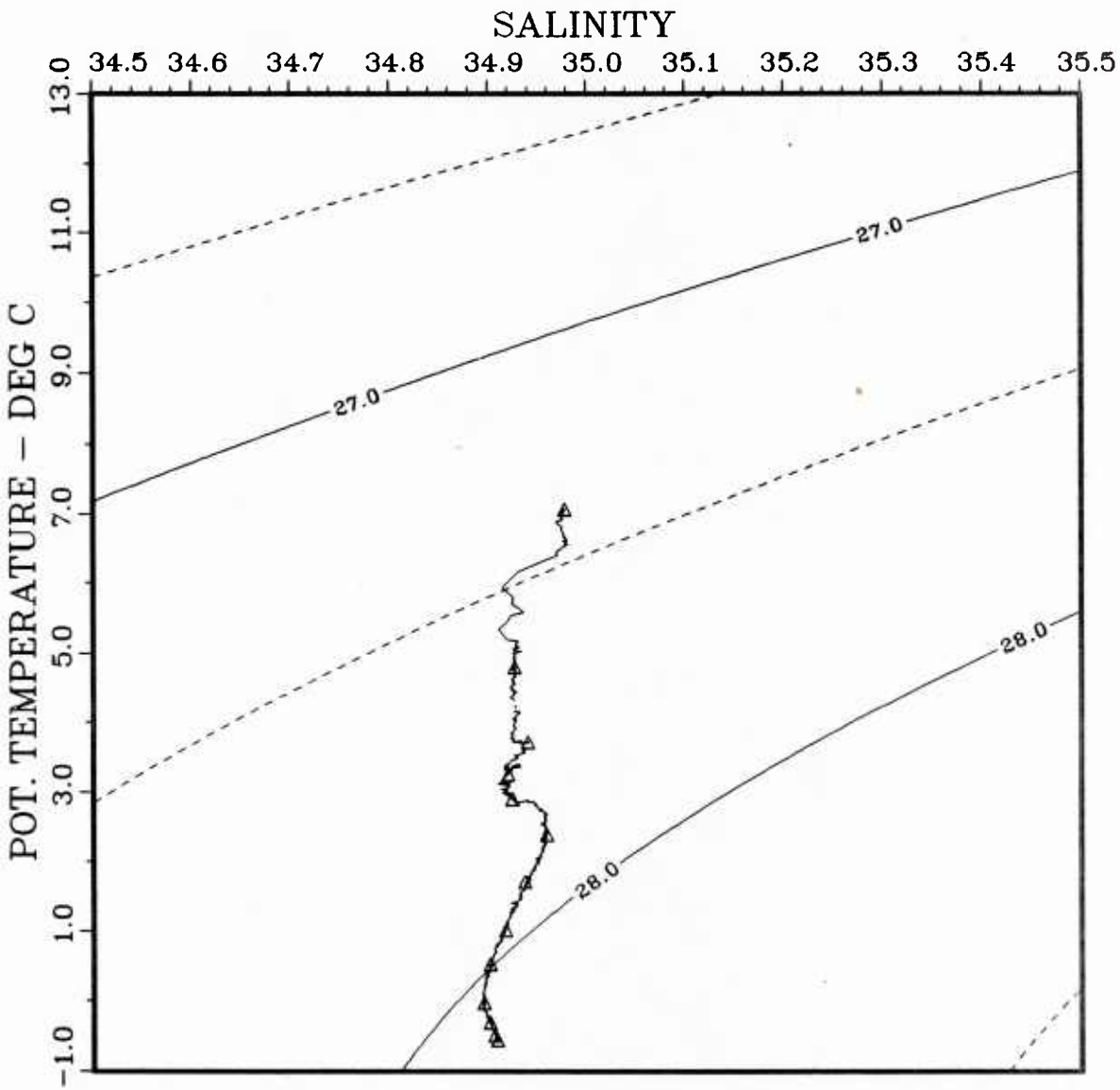



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 39 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0610 | |
| LATITUDE | 65 31.30N | |
| LONGITUDE | 003 36.81W | |

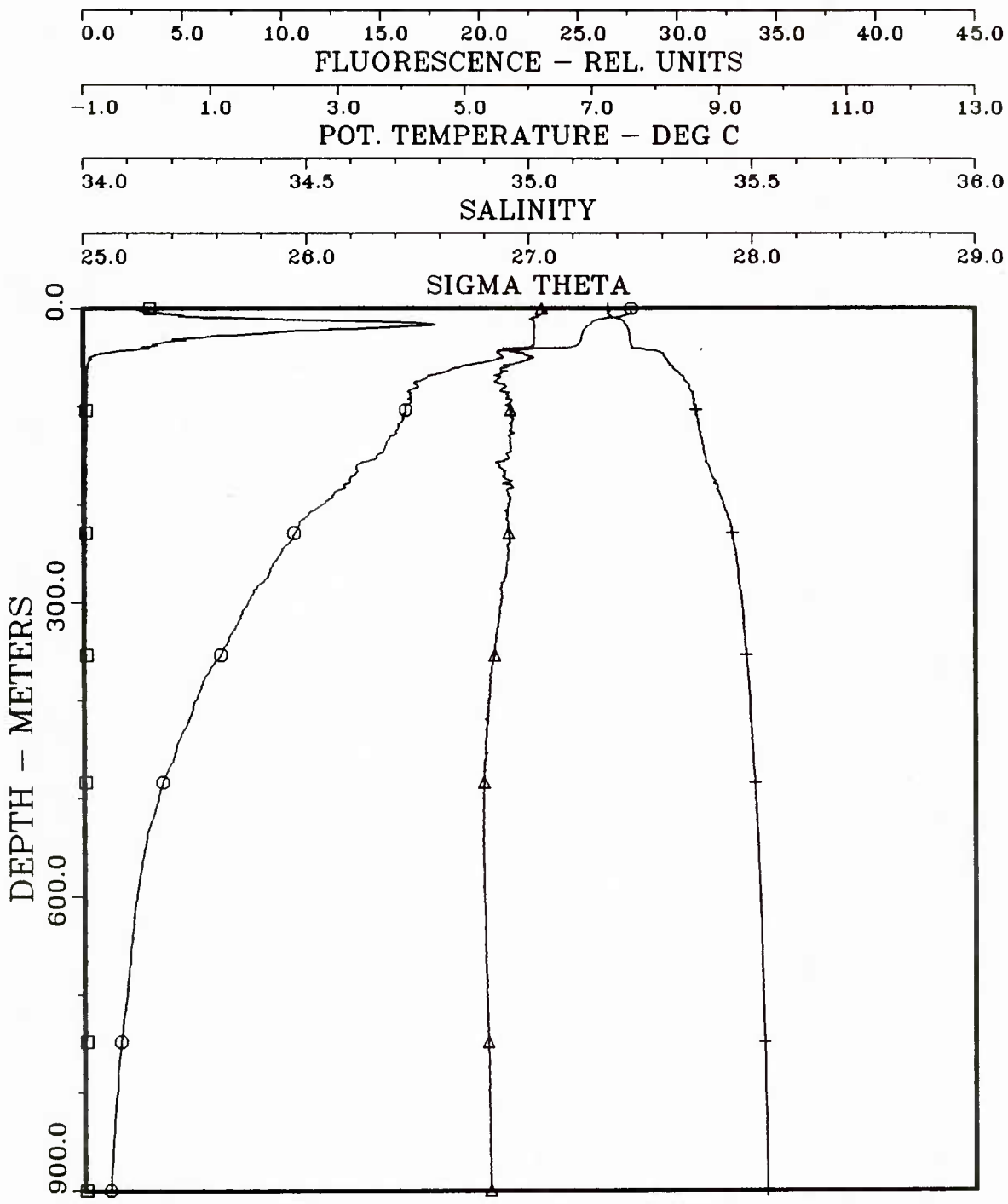



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 40 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0850 | |
| LATITUDE | 65 14.90N | |
| LONGITUDE | 002 56.71W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

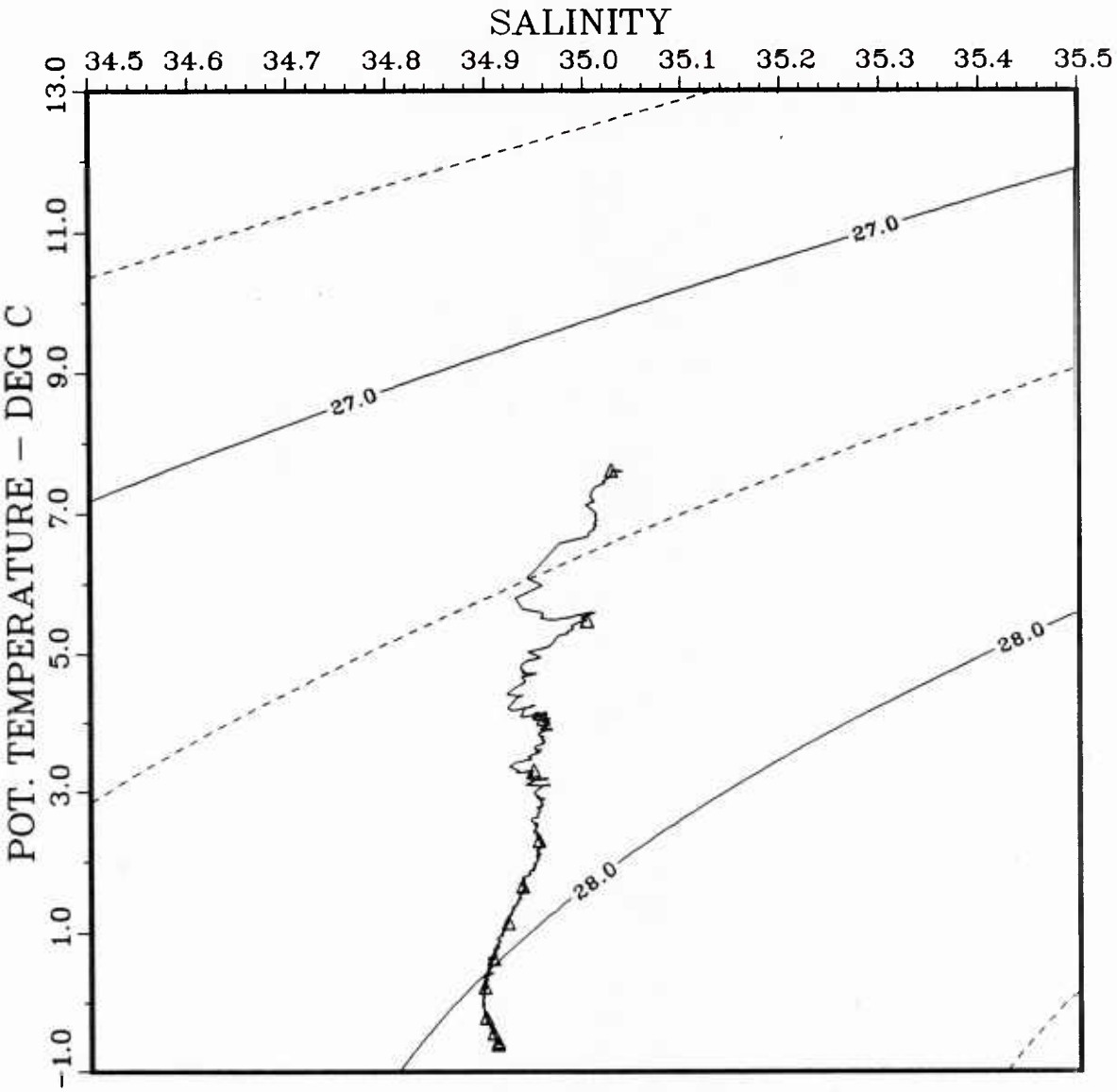



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 40 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.0850 | |
| LATITUDE | 65 14.90N | |
| LONGITUDE | 002 56.71W | |

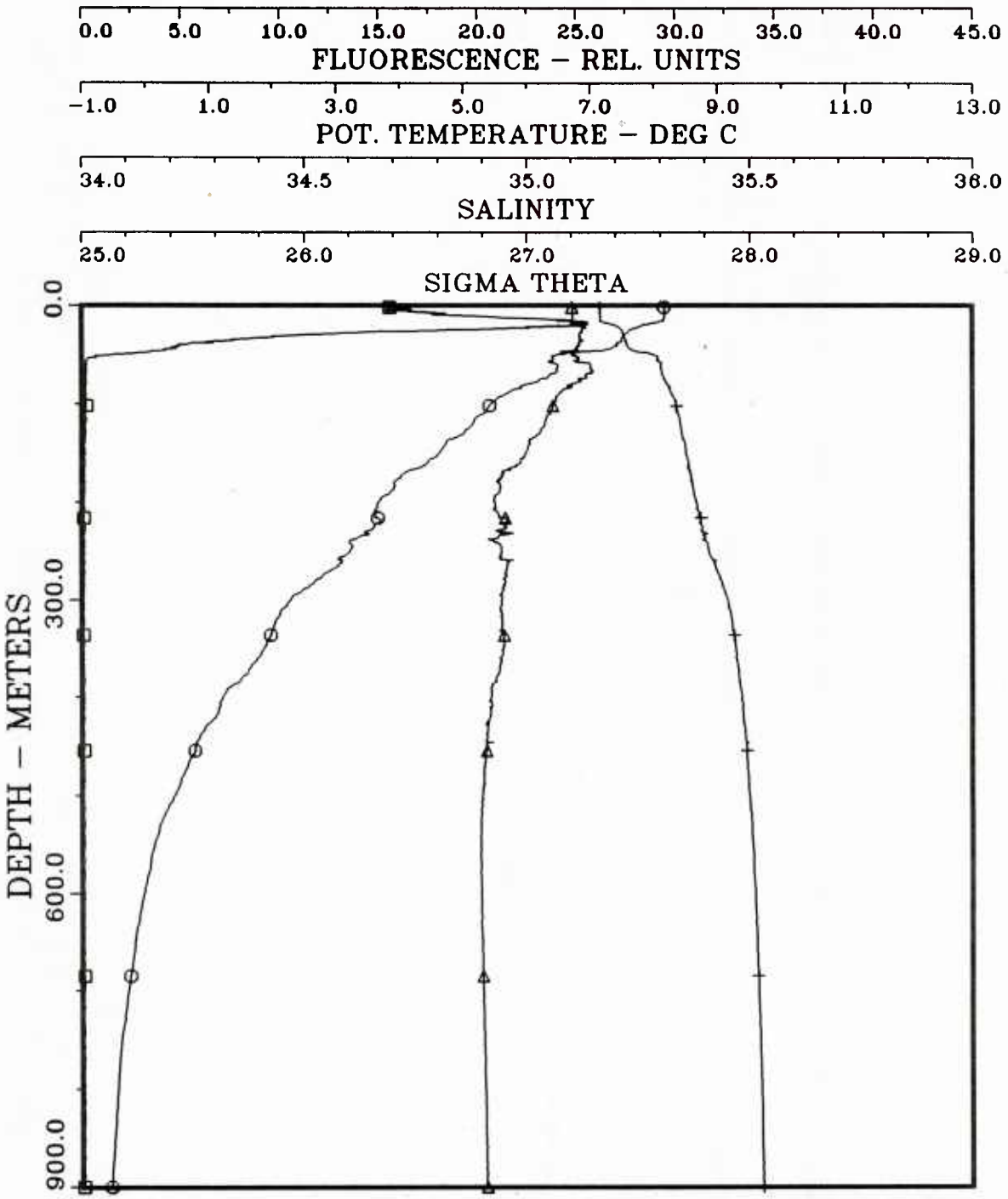



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 41 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.1150 | |
| LATITUDE | 64 59.18N | |
| LONGITUDE | 002 17.13W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

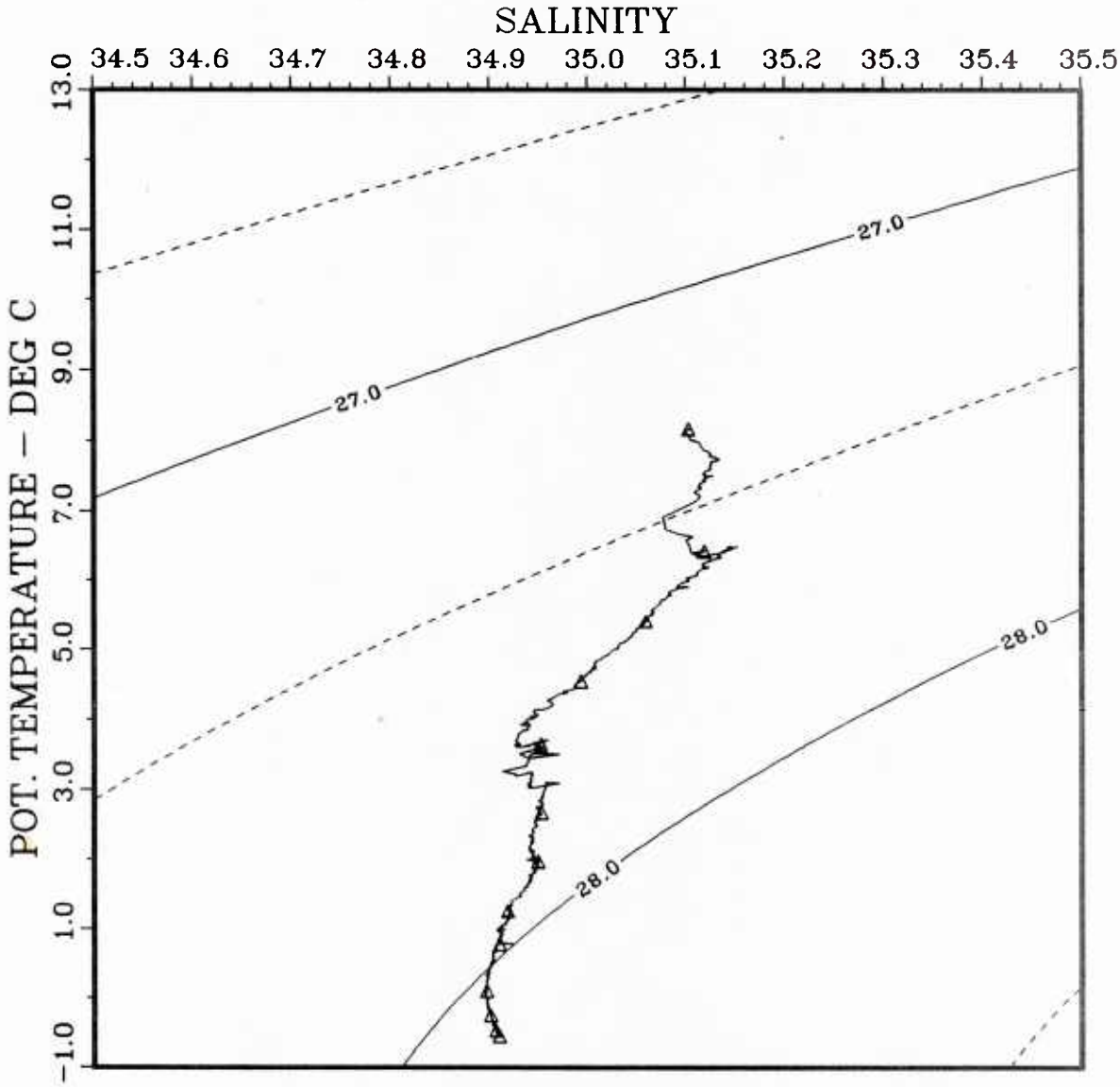



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 41 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.1150 | |
| LATITUDE | 64 59.18N | |
| LONGITUDE | 002 17.13W | |

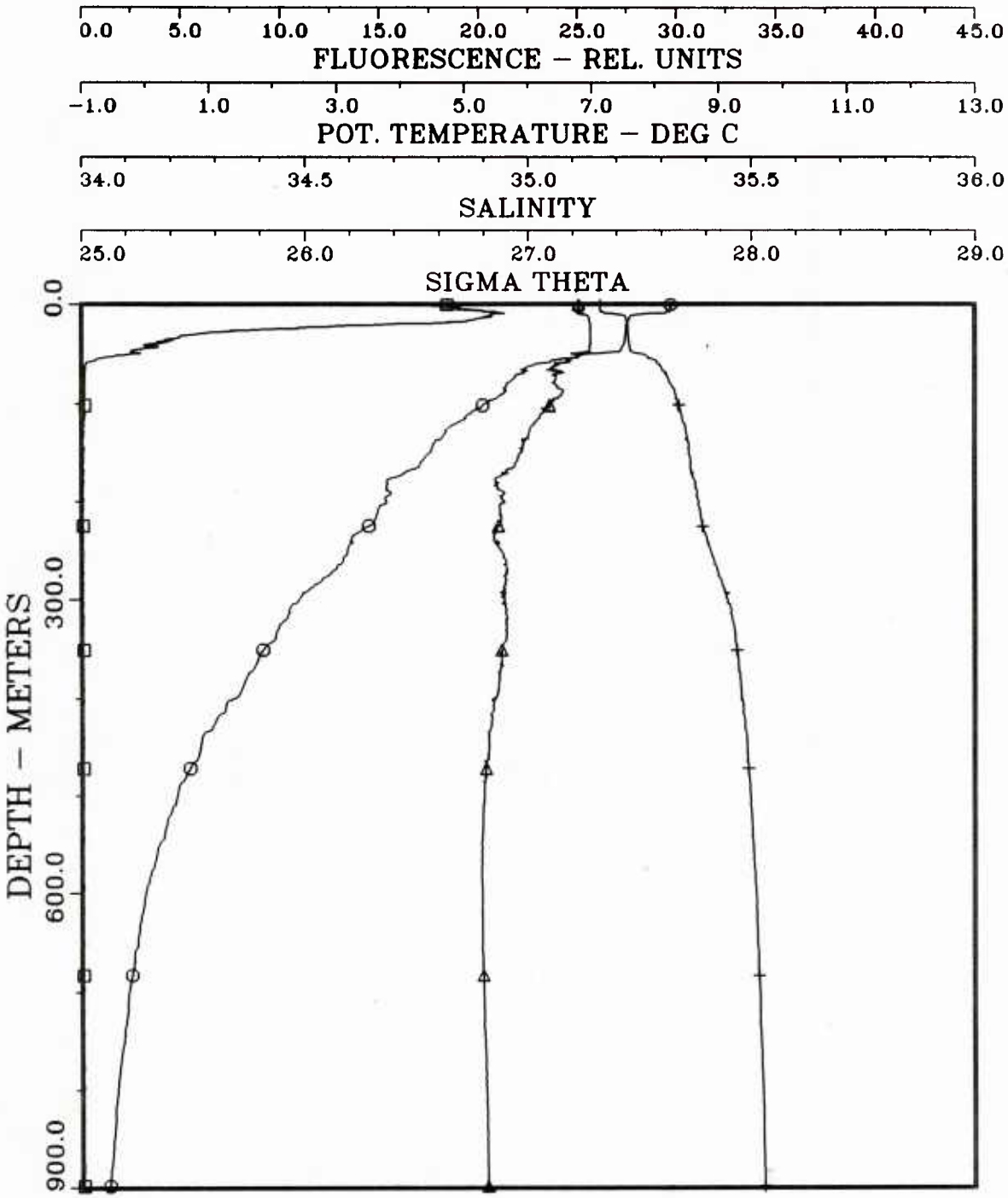



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 42 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.1430 | |
| LATITUDE | 64 42.80N | |
| LONGITUDE | 001 32.23W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

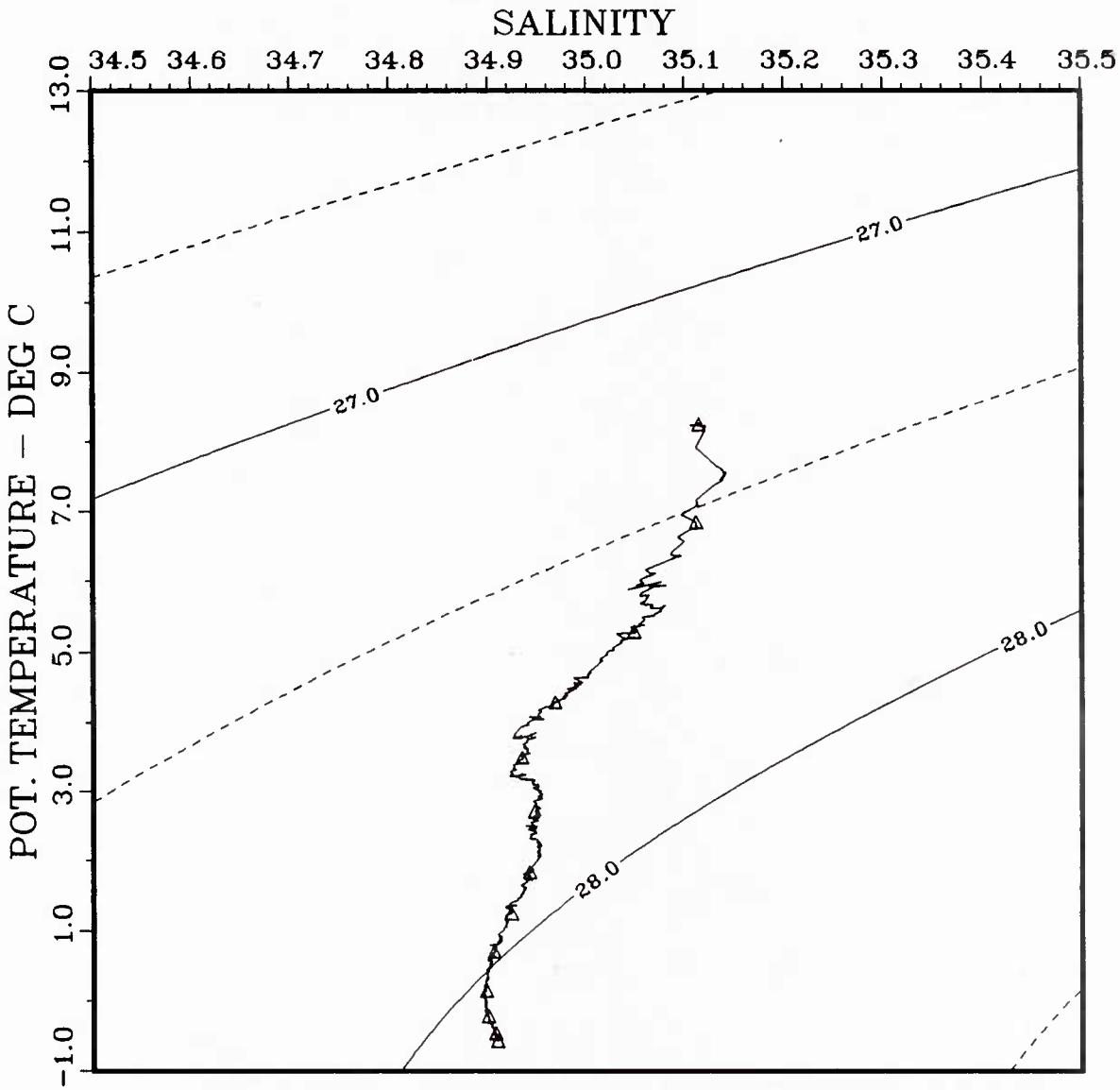



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 42 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.1430 | |
| LATITUDE | 64 42.80N | |
| LONGITUDE | 001 32.23W | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 43 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.1730 | |
| LATITUDE | 64 24.77N | |
| LONGITUDE | 000 48.80W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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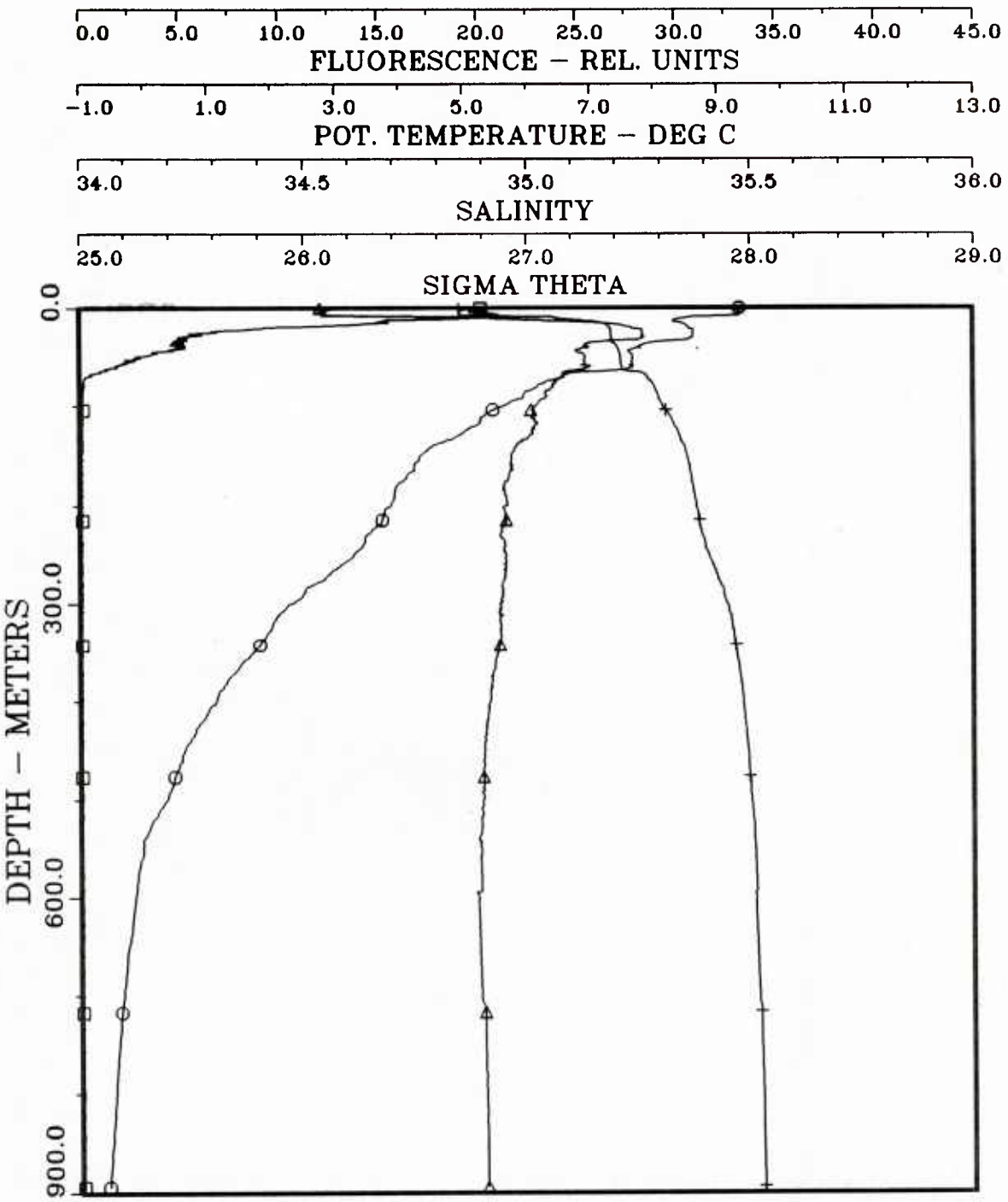
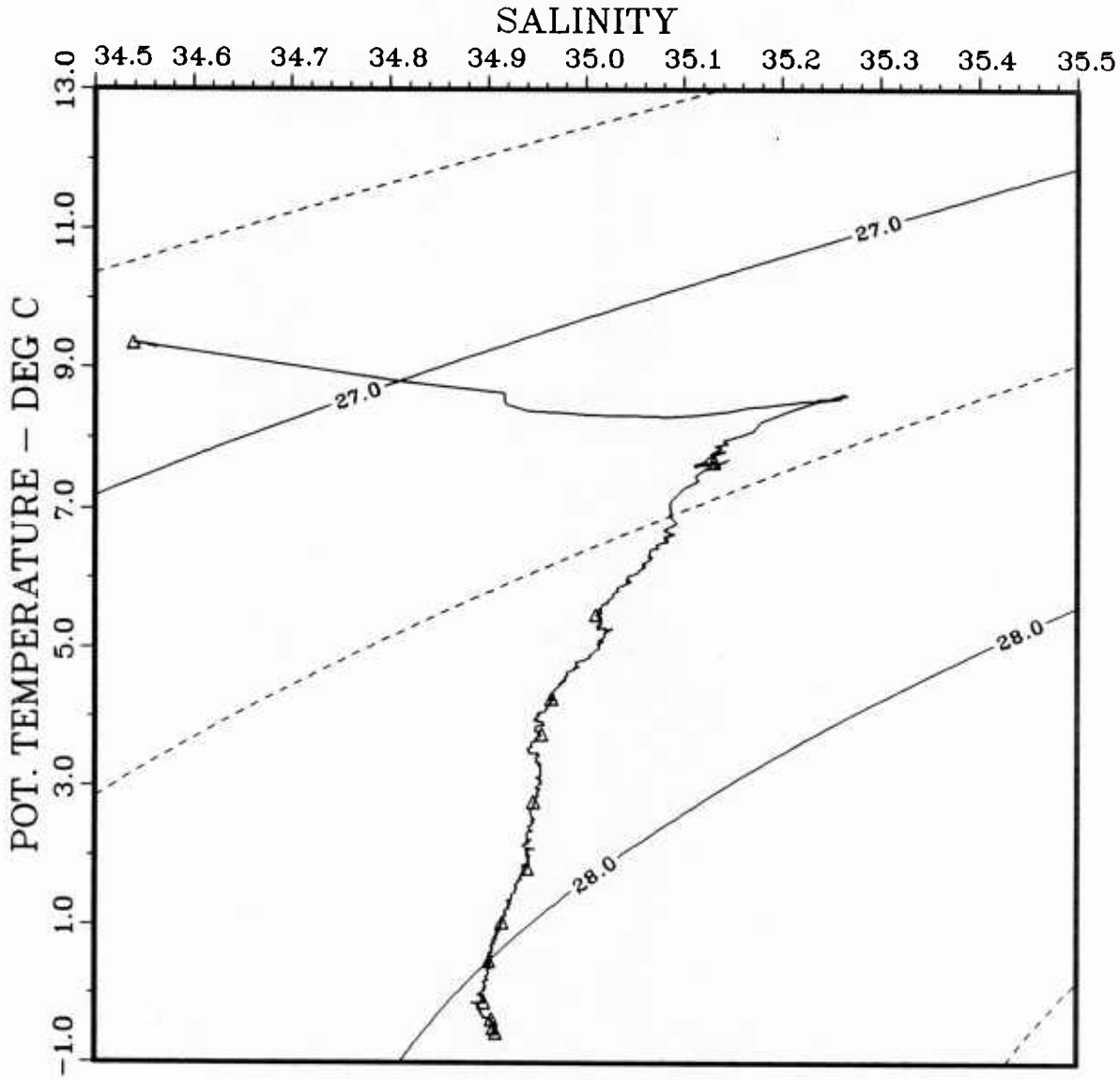
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 43 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.1730 | |
| LATITUDE | 64 24.77N | |
| LONGITUDE | 000 48.80W | |

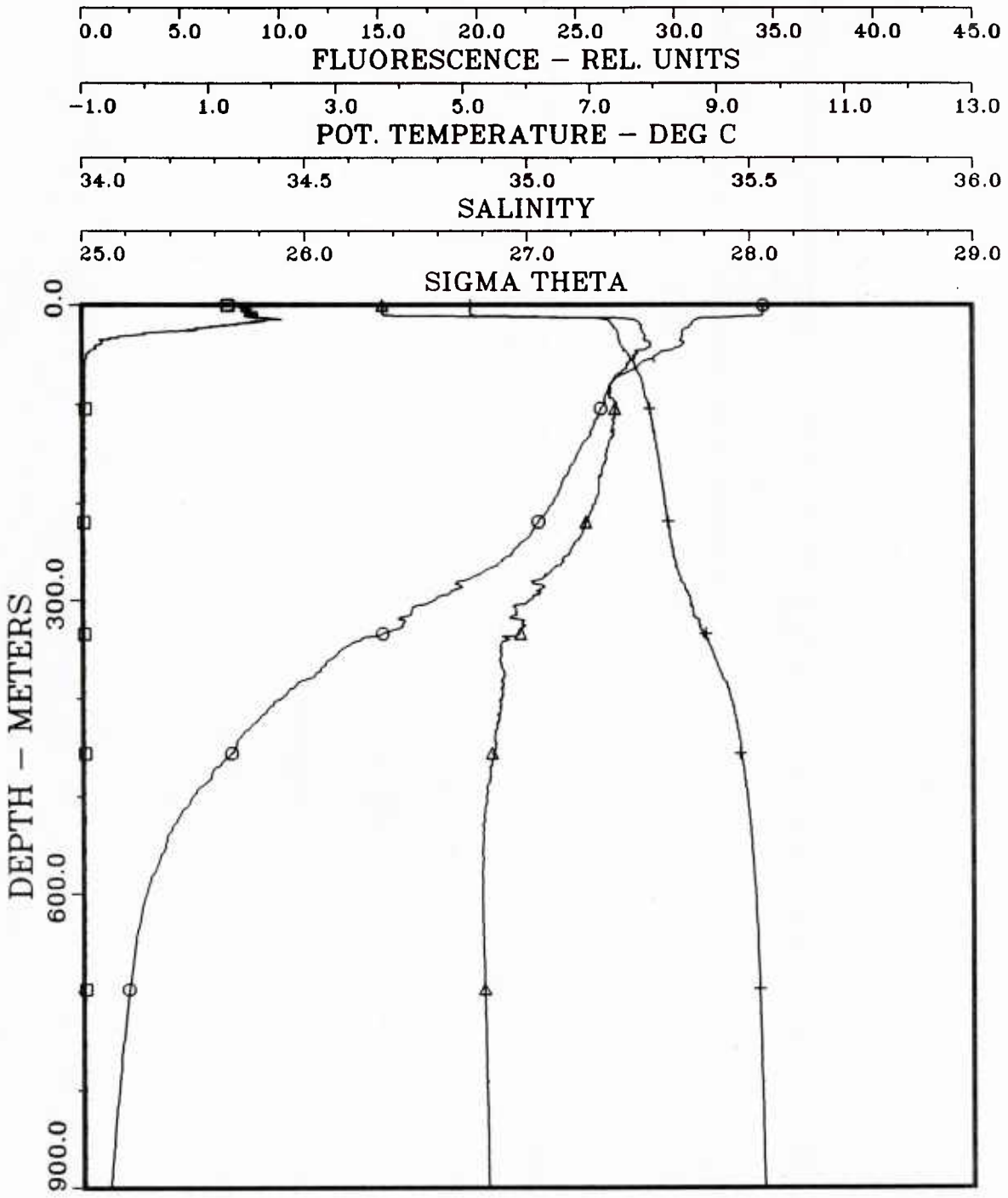



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 44 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.2030 | |
| LATITUDE | 64 06.80N | |
| LONGITUDE | 000 04.07W | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

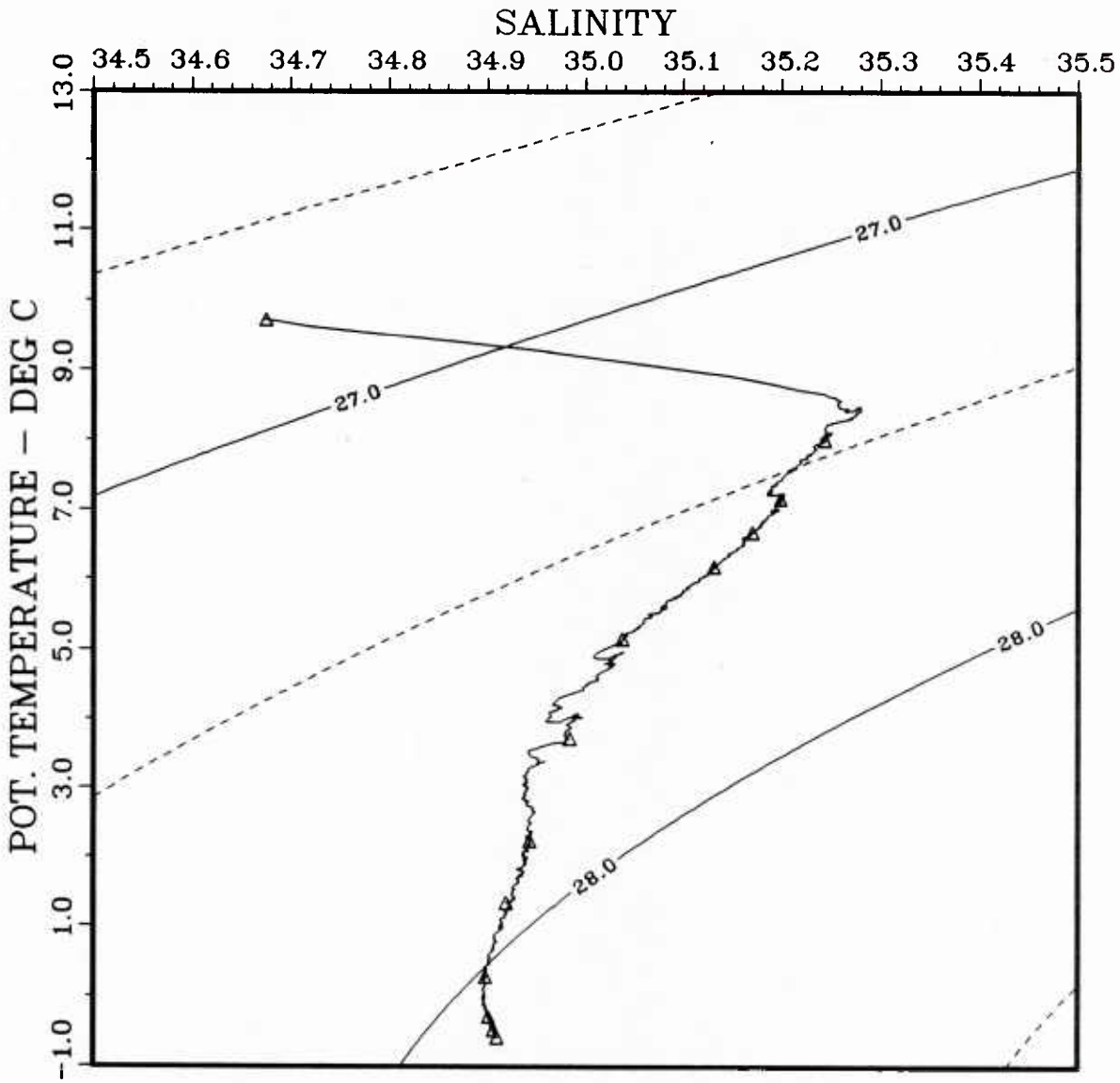



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 44 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.2030 | |
| LATITUDE | 64 06.80N | |
| LONGITUDE | 000 04.07W | |

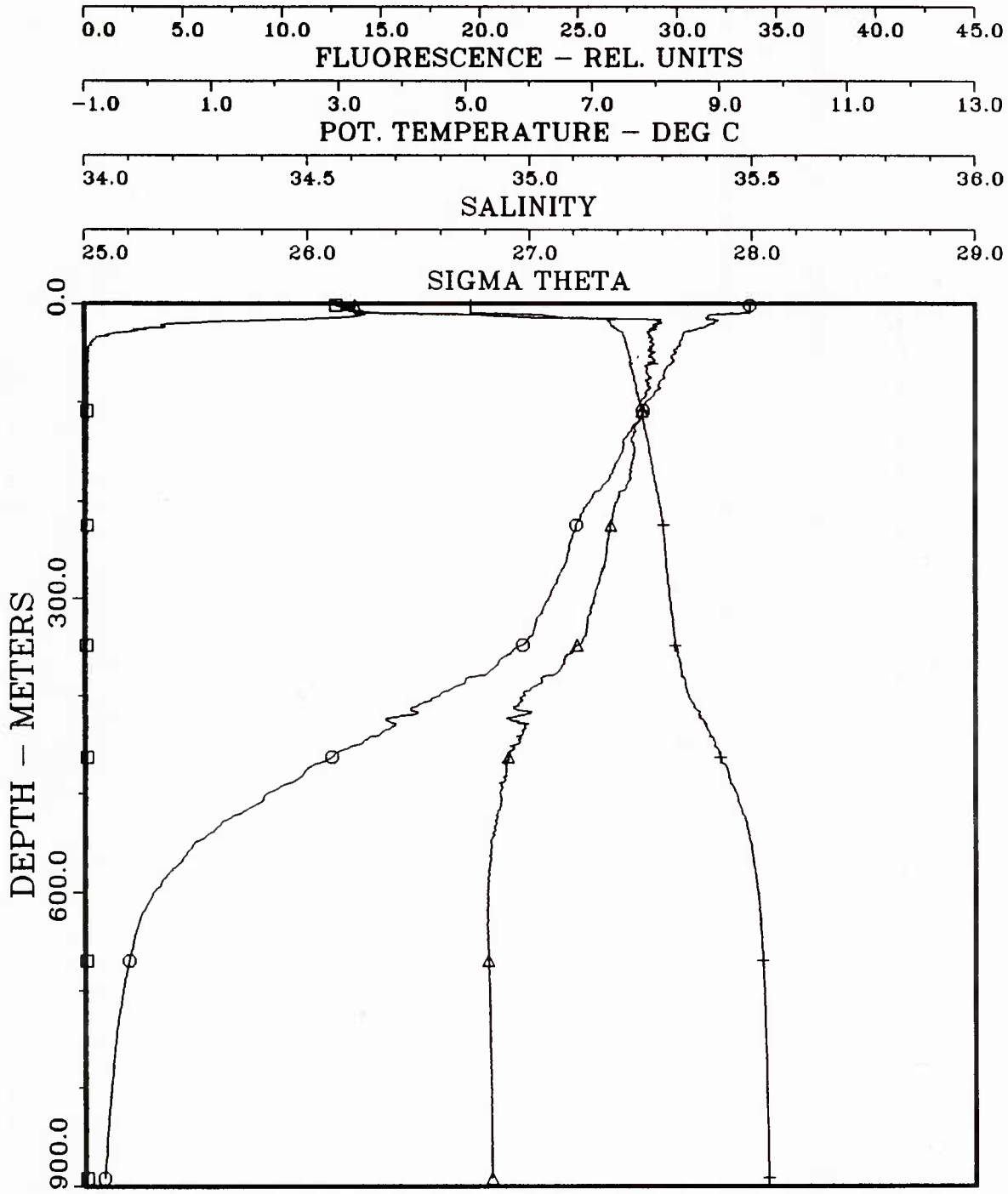



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 45 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.2330 | |
| LATITUDE | 63 47.11N | |
| LONGITUDE | 000 40.87E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

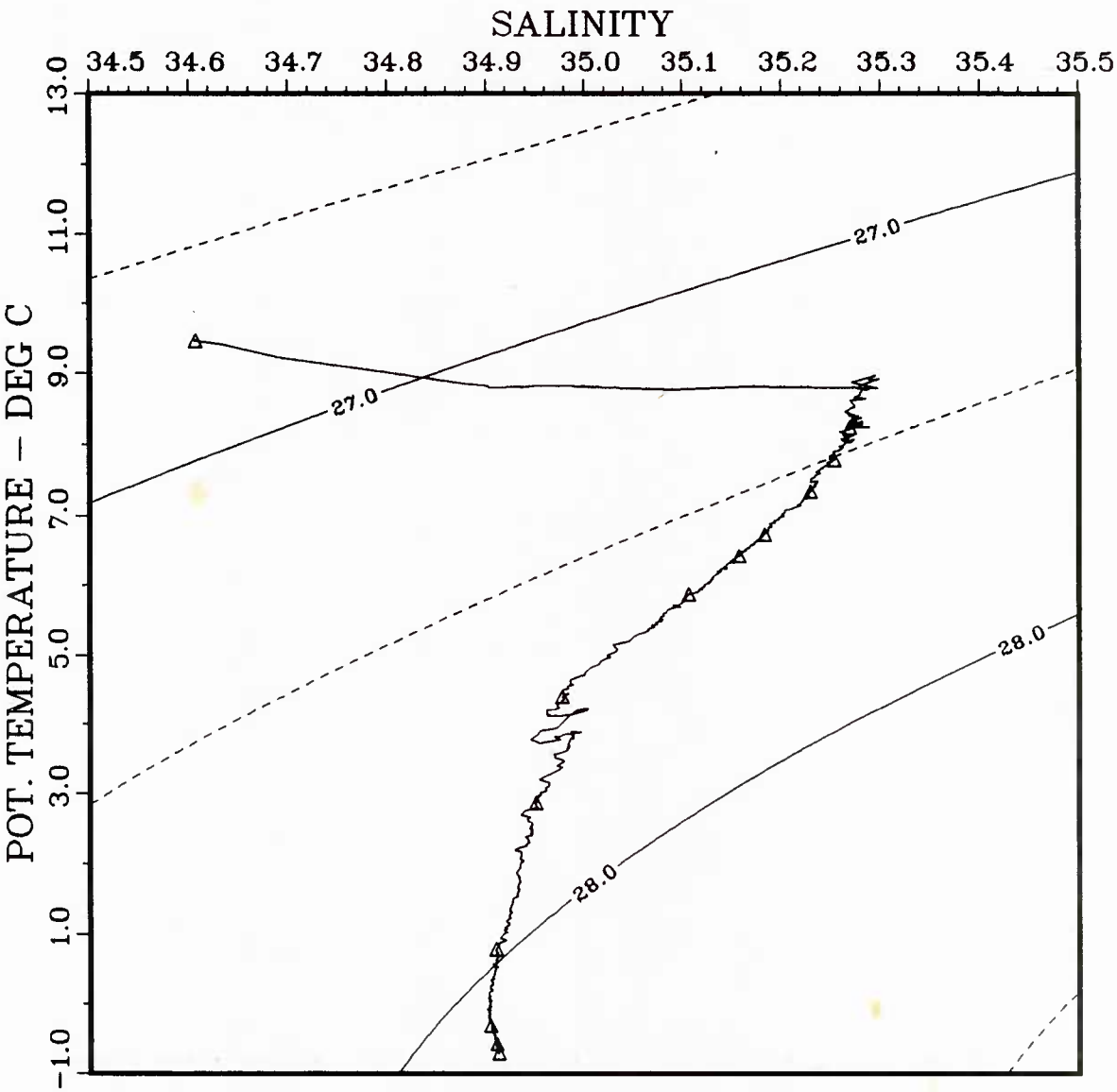



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 45 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 167.2330 | |
| LATITUDE | 63 47.11N | |
| LONGITUDE | 000 40.87E | |

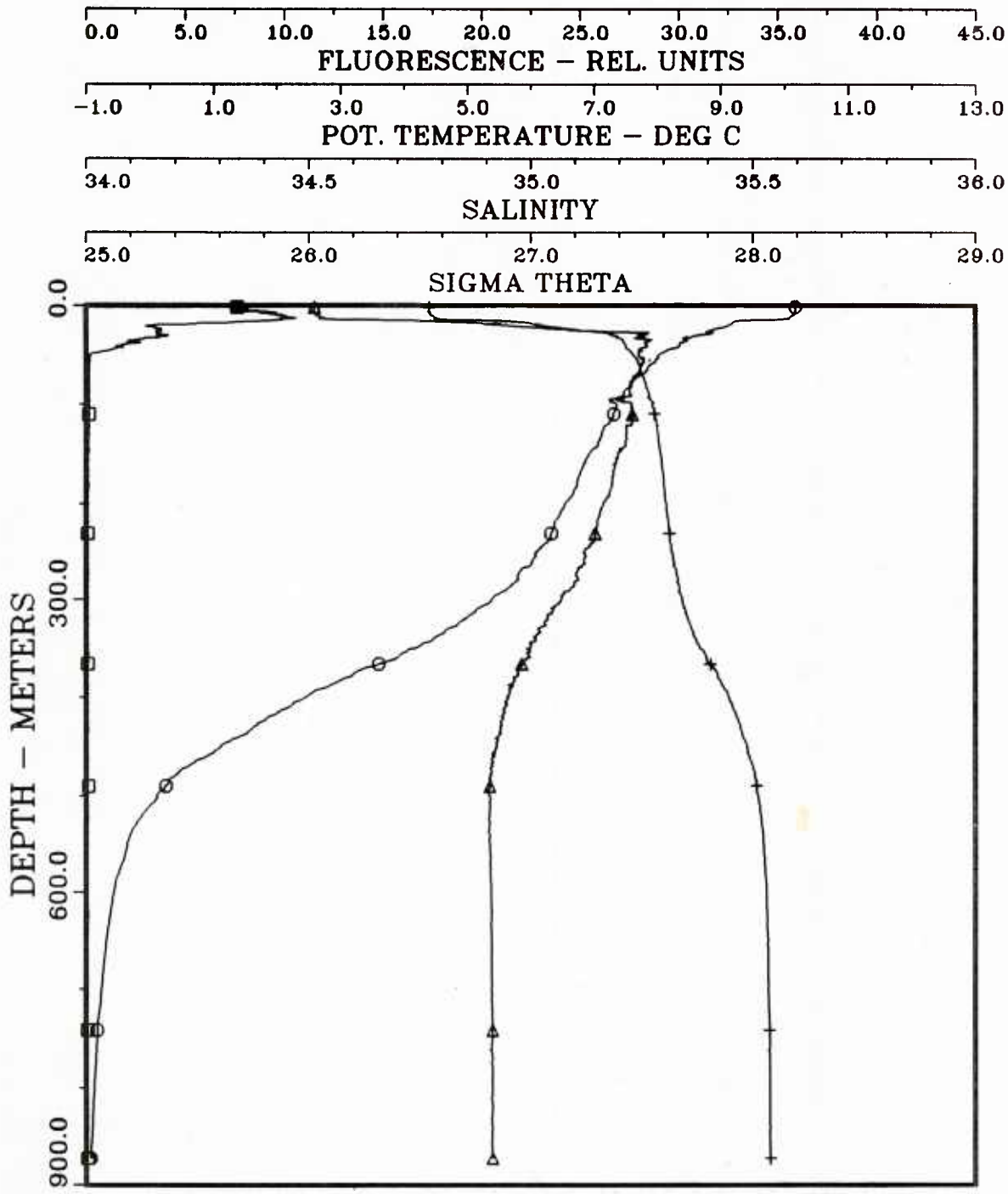



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 46 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.0230 | |
| LATITUDE | 63 27.67N | |
| LONGITUDE | 001 24.59E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

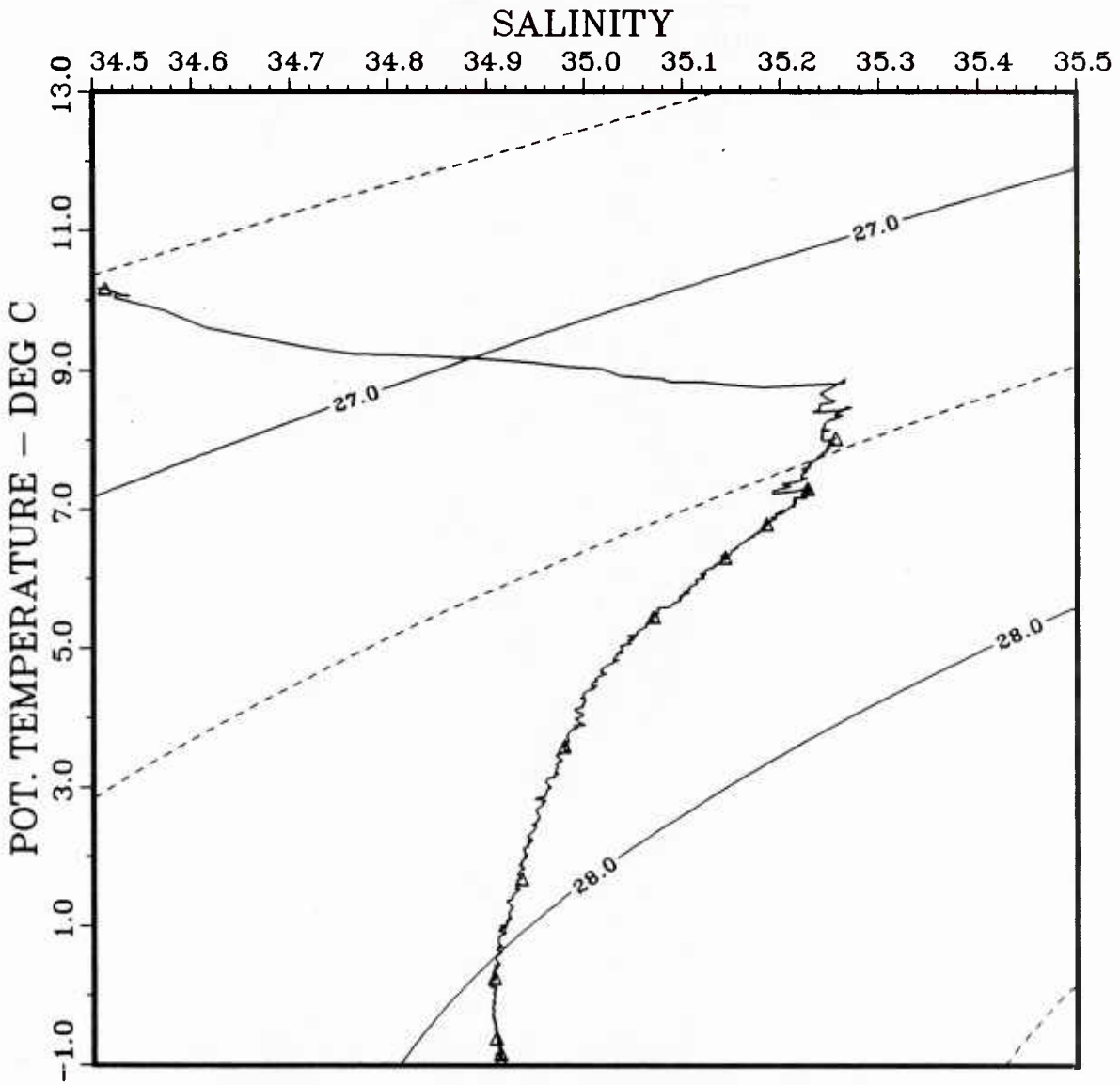



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 46 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.0230 | |
| LATITUDE | 63 27.67N | |
| LONGITUDE | 001 24.59E | |

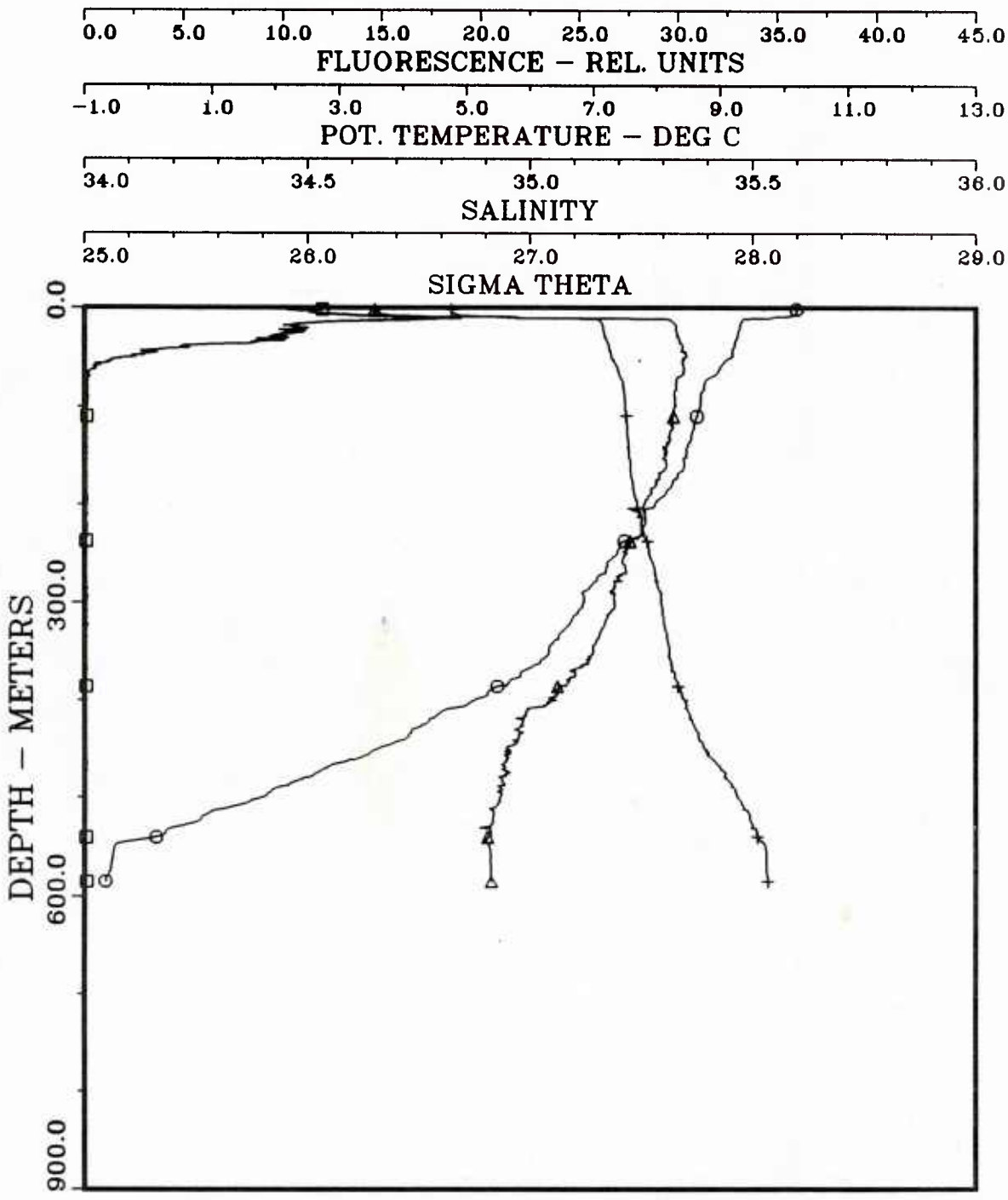



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 47 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.0550 | |
| LATITUDE | 63 07.65N | |
| LONGITUDE | 002 08.18E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

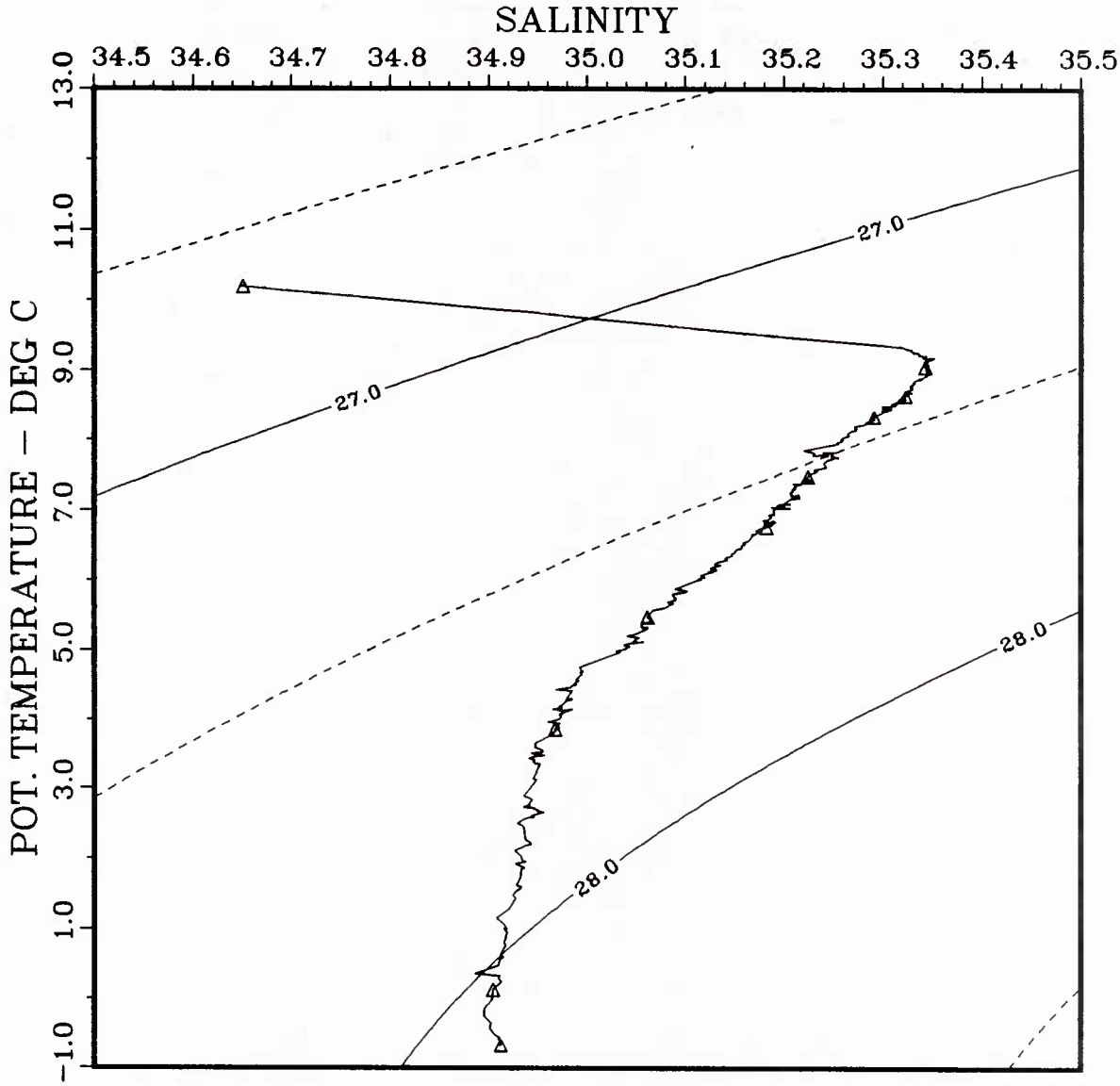



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 47 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.0550 | |
| LATITUDE | 63 07.65N | |
| LONGITUDE | 002 08.18E | |

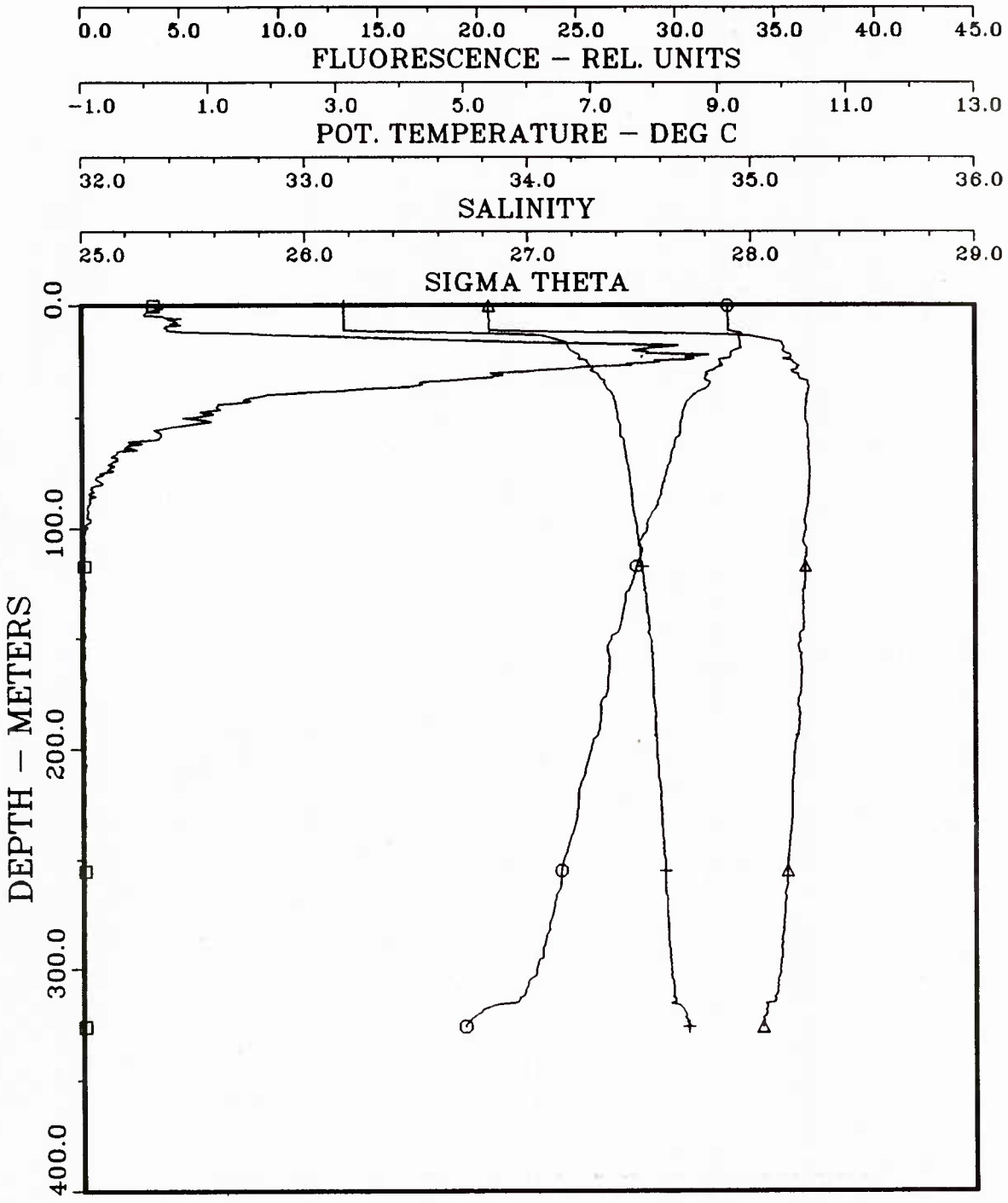



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 48 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.0910 | |
| LATITUDE | 62 46.55N | |
| LONGITUDE | 002 54.92E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

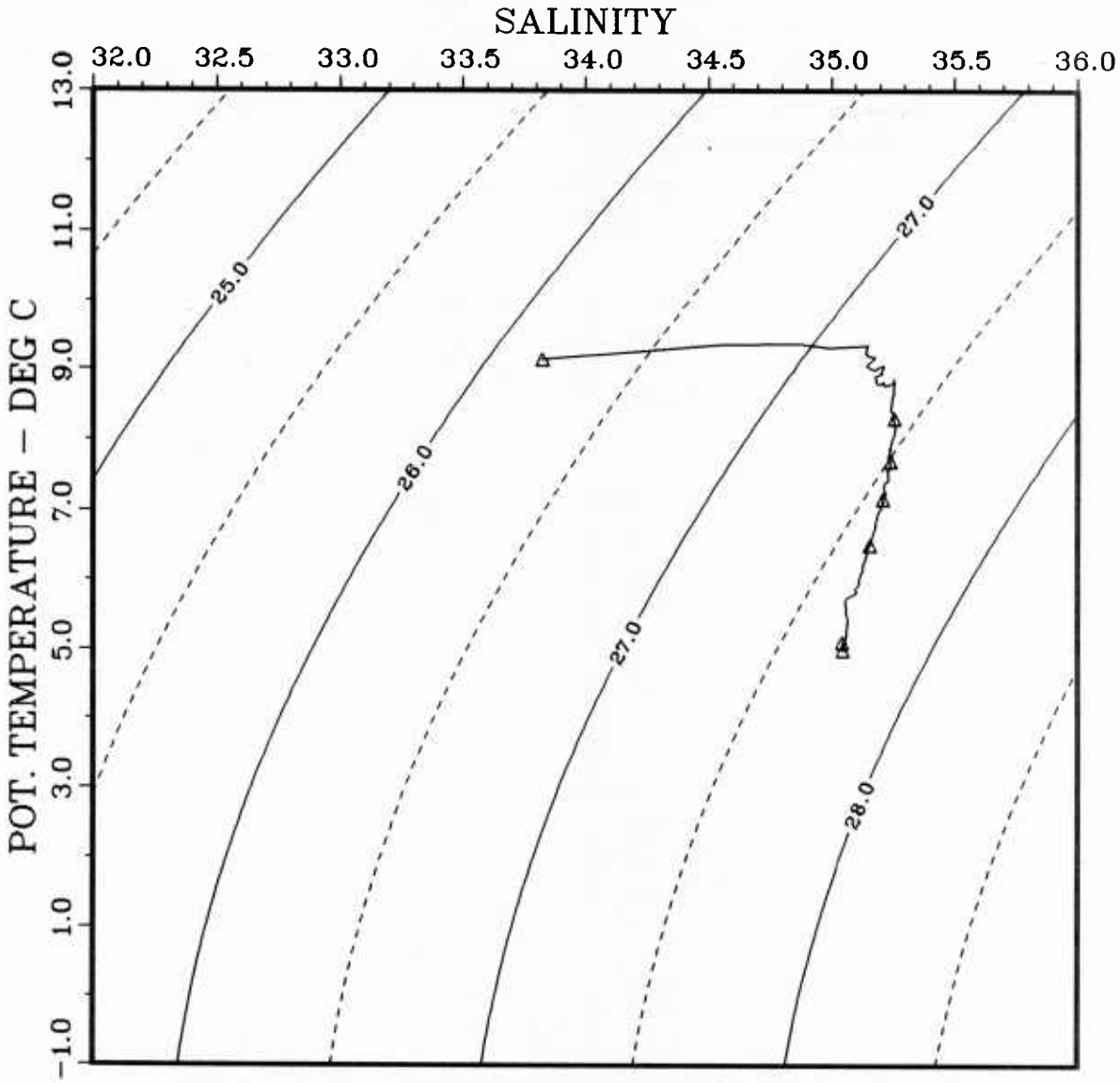



| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 48 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.0910 | |
| LATITUDE | 62 46.55N | |
| LONGITUDE | 002 54.92E | |




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 49 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.1130 | |
| LATITUDE | 62 35.89N | |
| LONGITUDE | 003 14.85E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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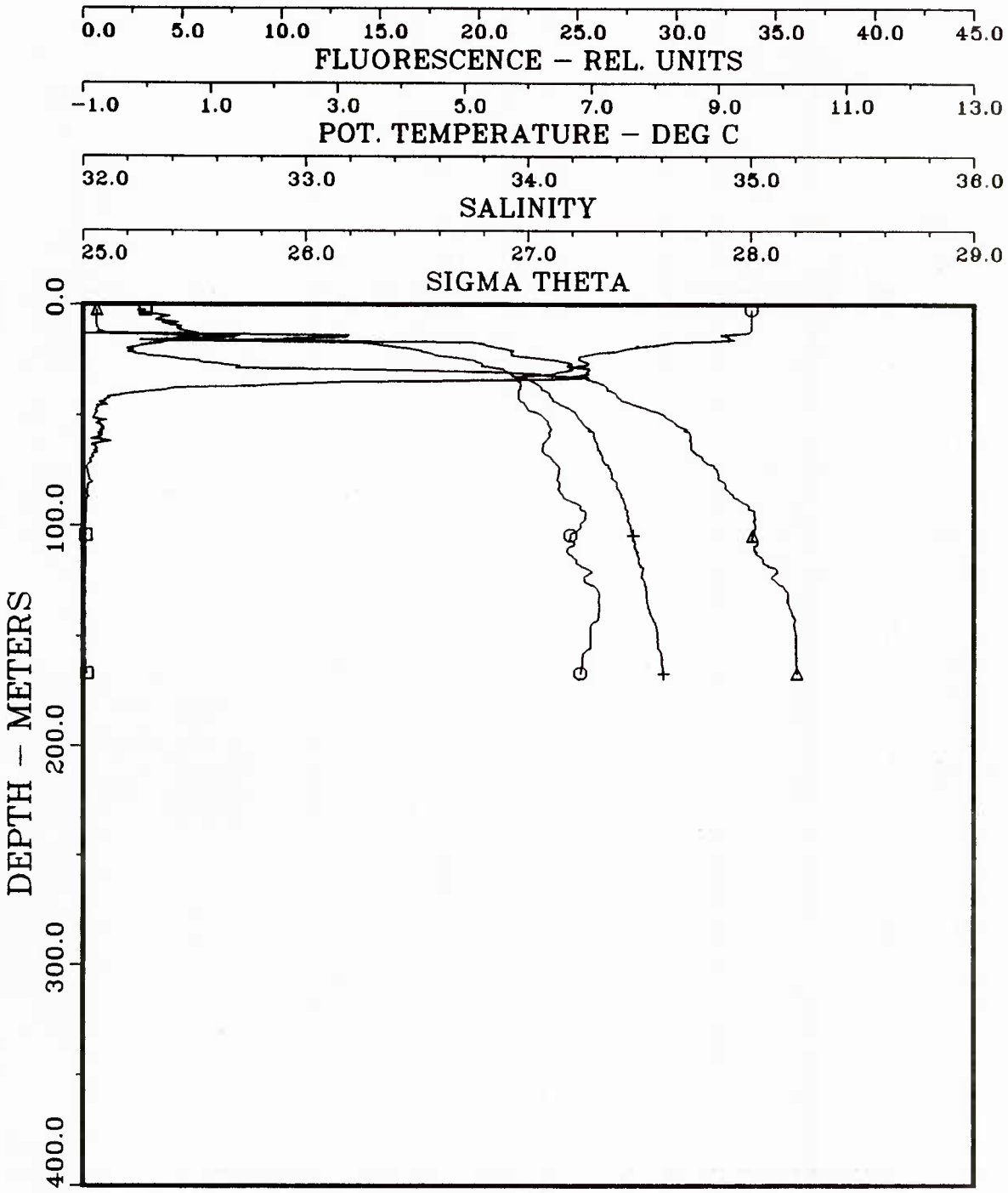
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 49 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.1130 | |
| LATITUDE | 62 35.89N | |
| LONGITUDE | 003 14.85E | |

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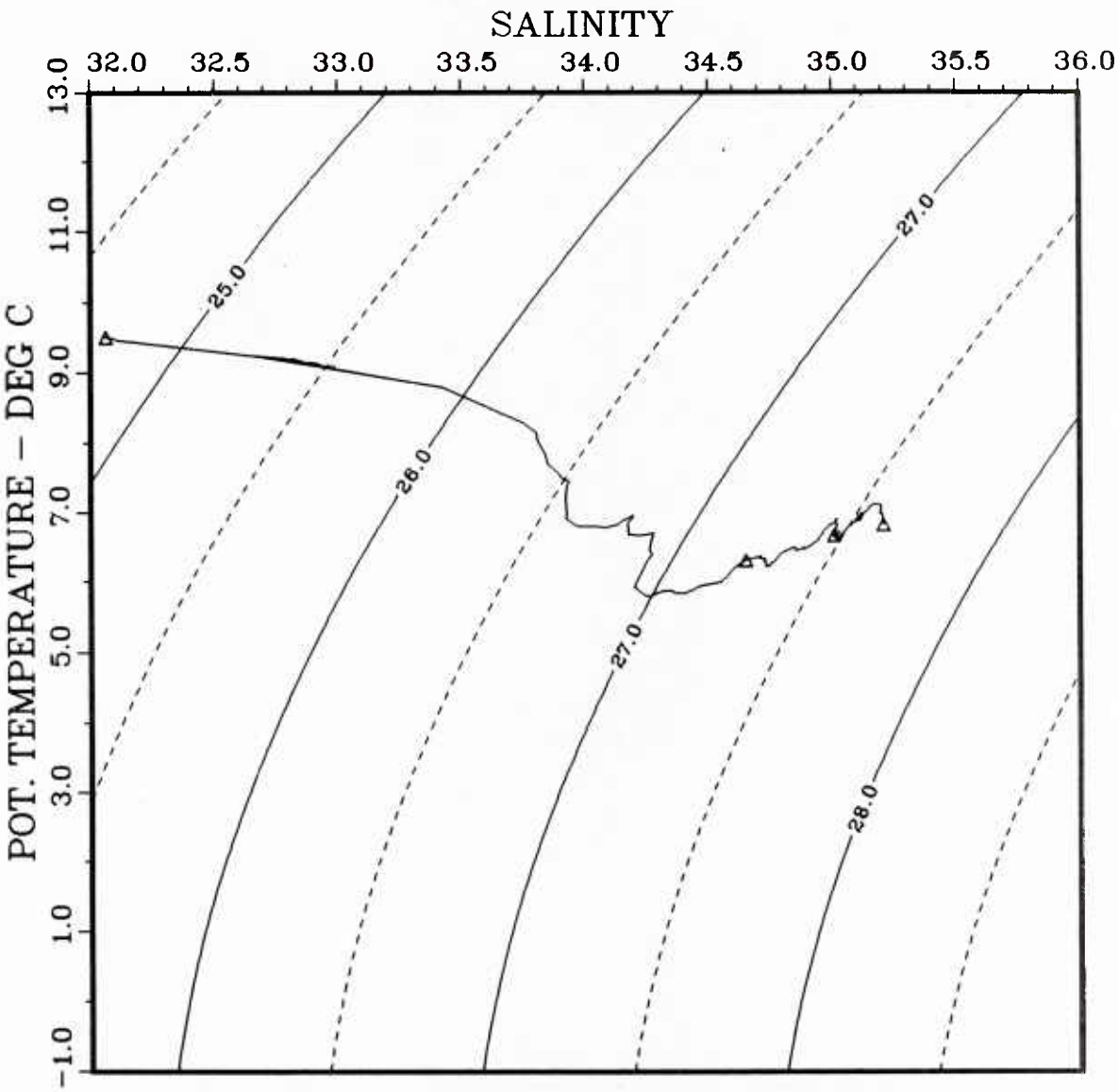
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 50 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.1330 | |
| LATITUDE | 62 25.37N | |
| LONGITUDE | 003 36.75E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA

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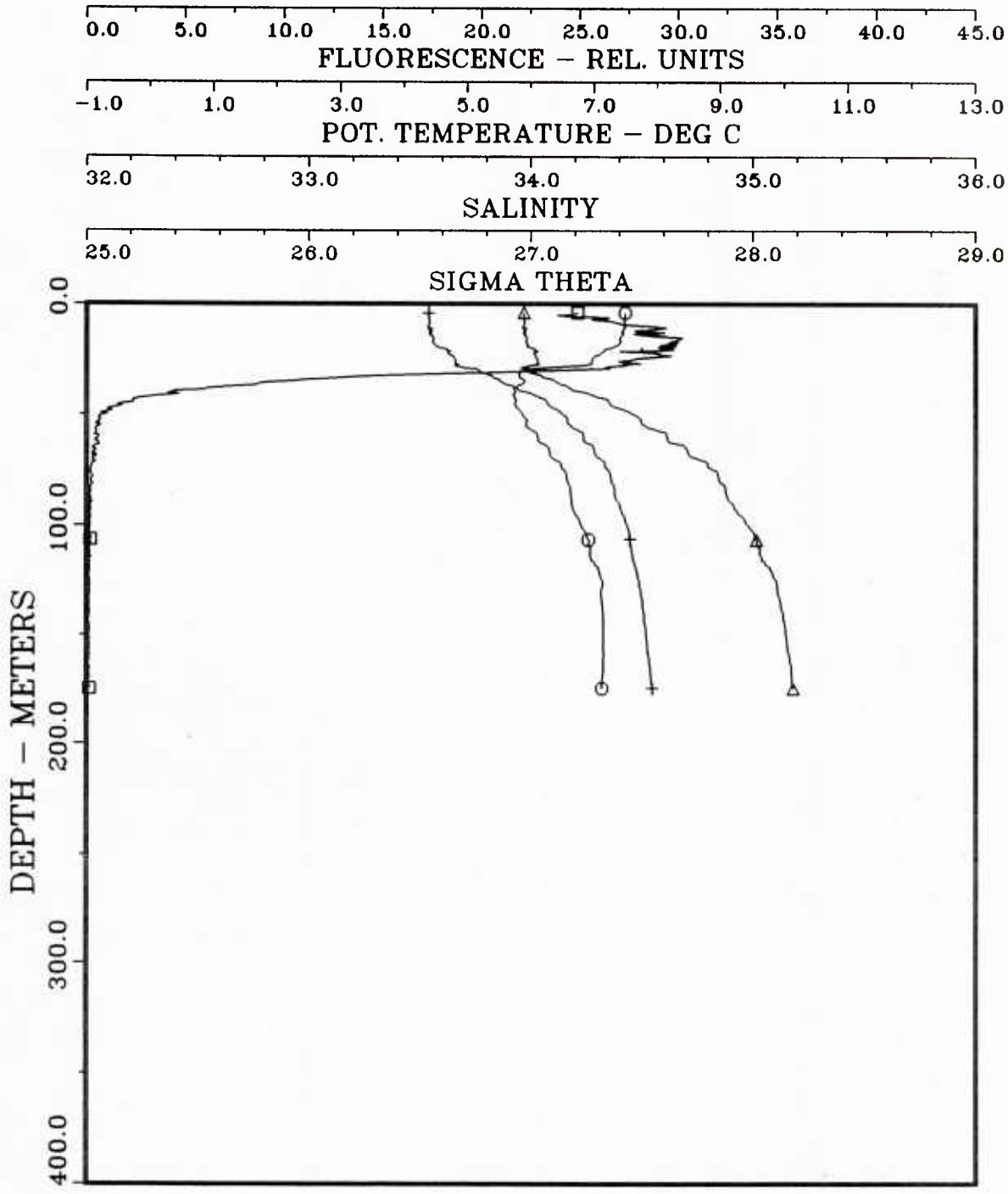
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 50 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.1330 | |
| LATITUDE | 62 25.37N | |
| LONGITUDE | 003 36.75E | |

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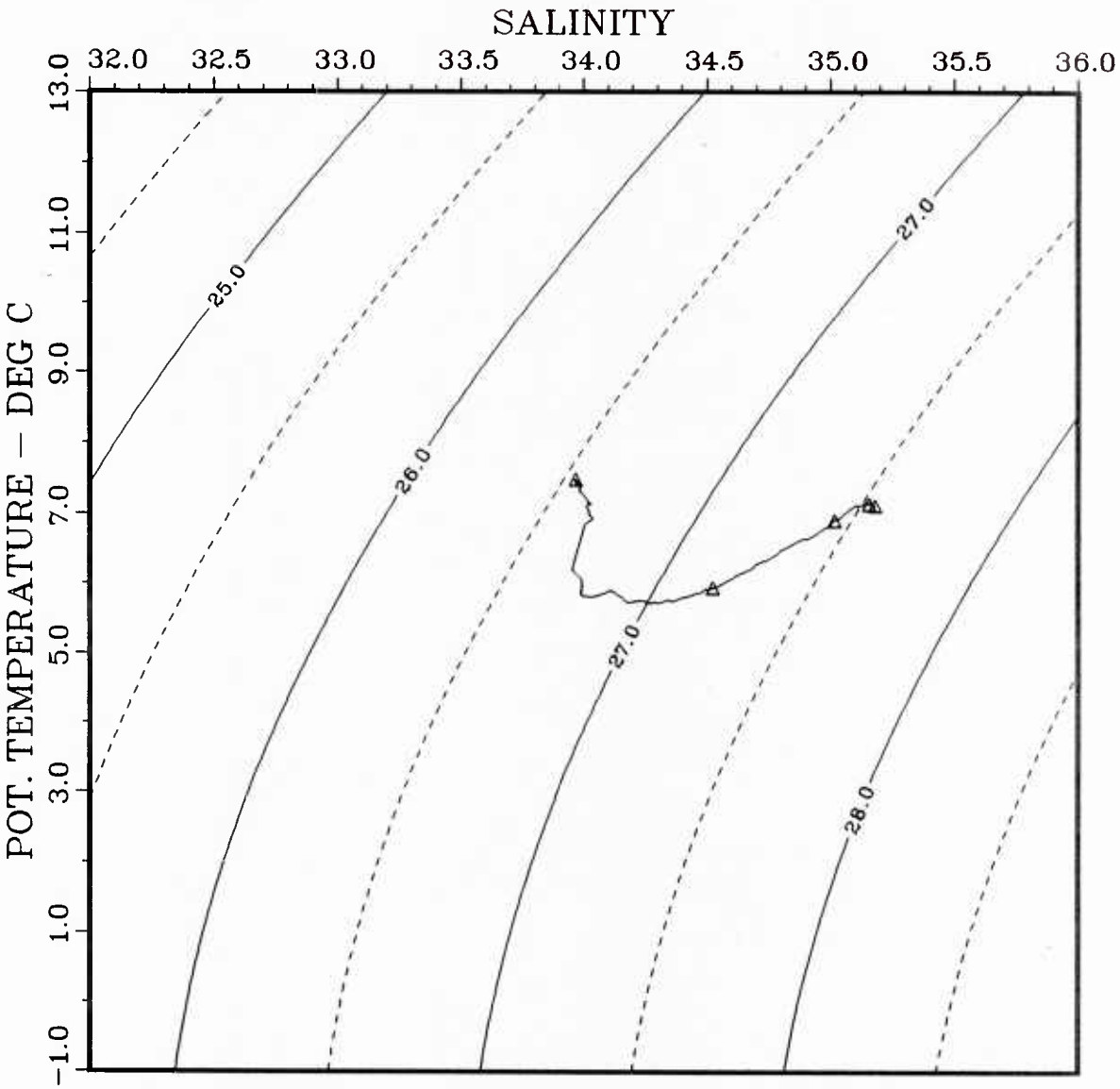
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 51 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.1650 | |
| LATITUDE | 62 04.21N | |
| LONGITUDE | 004 21.32E | |

LEGEND
□ = FLUORESCENCE
○ = POT. TEMPERATURE
△ = SALINITY
\+ = SIGMA THETA




| | | |
|---|---|---|
| WFS PLANET | NORDMEER 87 | JUNE 1987 |
| STATION | 51 | |
| CAST NUMBER | 1 | |
| JULIAN DATE | 168.1650 | |
| LATITUDE | 62 04.21N | |
| LONGITUDE | 004 21.32E | |